THE ILLUMINATING ENGINEER

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LAMPS
FITTINGS
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ILLUMINATION

THE JOURNAL OF
GOOD LIGHTING

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OFFICIAL ORGAN of
The Illuminating Engineering Society
(Founded in London, 1909; Incorporated 1930)
and of
THE ASSOCIATION OF PUBLIC LIGHTING ENGINEERS
(Founded 1923; Incorporated 1928)

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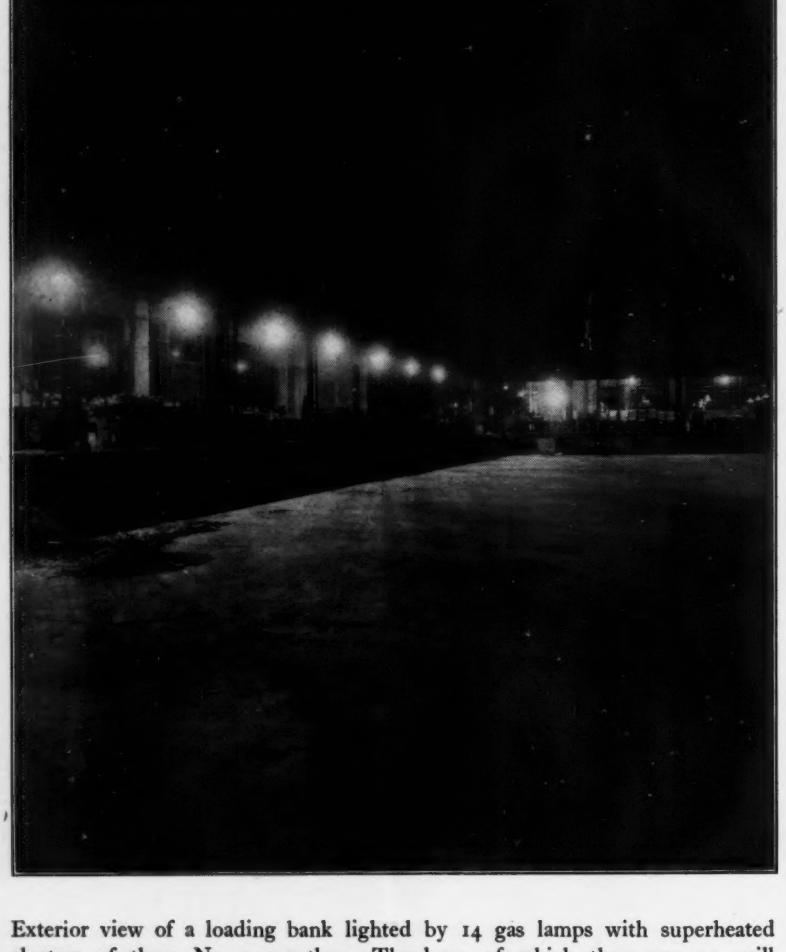

Exterior view of a loading bank lighted by 14 gas lamps with superheated clusters of three No. 2 mantles. The bays, of which there are 14, will accommodate 28 lorries. The light is adequate not only for loading, but for checkers to make their notes. The lamps are specially designed for positions where immunity from wind and weather is essential. On the evening when the photograph was taken there was a moderate wind, but the lights remained absolutely steady. Each lamp has a lever cock and flashing by-pass, and is separately controlled. Individual bays can, of course, be lighted up separately when the whole series is not in use at once.

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Edited by
J. STEWART DOW

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Problems in Illuminating Engineering

THE meeting of the Illuminating Engineering Society, on February 18th, devoted to a series of Problems in Illuminating Engineering," proved quite as successful as similar evenings in the past. A varied series of topics was discussed; it is noteworthy that several of the most interesting contributions came from people outside the ranks of the Society. As usual, the meeting provided an opportunity for several of the younger members to contribute. This principle we should like to see developed. The preparation of a paper to fill a complete evening may be regarded as a formidable task; but the presentation of a "problem," in an address occupying only 10 to 15 minutes, should be within the compass of almost everyone, and there can be few members of the Society, young or old, who have not had interesting experiences well worth relating.

The opening problem, dealt with by Mr. T. F. H. Marsh, in the absence of Mr. W. J. Jones, was a somewhat fundamental one—namely, the study of the relation between illumination and "seeing power." The ingenious test prescribed (joining up dots on a sheet of paper) can be carried through quite quickly, and it does call into play various visual operations usual in industrial and office work, whilst perhaps going beyond such simple operations of writing and reading. Such tests should be regarded as illustrating the general principle that, within limits, increased illumination improves "seeing power." But one should, of course, be cautious in drawing detailed conclusions regarding the effect on output or quality of work in operations which may differ materially from those utilized in the test.

Subsequent problems consisted mainly of descriptions of lighting installations interesting either for their unusual character or for the exceptional difficulties presented. The system of lighting in the reorganized Kingsway subway, which Mr. J. H. Parker described, is in some respects original. The floodlighting, which forms the main basis of the station lighting, is decidedly effective; the emergency lighting, the general system of lighting the tunnels, and the illuminated notice advertising the tramways all present points of interest.

Mr. Oliver Bernard's discourse on the lighting at the International Exhibition of Persian Art, to which we alluded in our last number, was chiefly interesting for its elucidation of "point of view." People are somewhat apt to judge lighting installations simply in terms of the perfection or otherwise of technical details; sometimes they lose sight of one extremely important question—the primary object which the lighting is to serve. Mr. Bernard contended, with some reason, that in this case the dominant consideration was to render the exhibits attractive—and, judging from the attendance, it must be assumed that this aim was realized. On such occasions *vox populi vox Dei* doubtless applies. It was pointed out that not one in a hundred of the visitors would have expert knowledge of Persian Art; hence it was more desirable that the objects shown should be presented in romantic aspect than that all details should be displayed with matchless precision. (It would appear, nevertheless, that experts were also satisfied by the colour-lighting adopted.) In one respect, we think, it must be owned that the lighting arrangements did not satisfy requirements; the apparatus was admittedly rather prominently in evidence. In lighting for display, the more completely the equipment can be hidden the better. It is only fair to acquit Mr. Bernard and his assistants of blame in this connection; it would seem that the trouble had a familiar origin, namely, the late date at which advice was asked. We wish it could be impressed on the mind of all organizers of exhibitions that the lighting—on which the whole appeal to the eye depends—should be one of the very first things to receive consideration.

The other installations described were all in some degree distinctive. Mr. Harold Long discussed the illumination of furniture travelling on a moving belt and subjected to spraying operations; Mr. Ives illustrated the floodlighting of a high tower in somewhat difficult circumstances, and Mr. G. W. Golds described a most unusual warehouse-lighting installation, in which illumination was afforded by travelling portable units of special design.

The latter struck us as a particularly interesting example of the utility of local lighting. General overhead lighting, owing to its simplicity, is now very widely adopted and answers requirements in the majority of cases. But circumstances are quite frequently met with that favour the use of local lights—either because a quite exceptionally high illumination, such as it would be too expensive to furnish by ordinary methods, is desired, or because—as in this instance—the area to be lighted is exceedingly large and light is only needed for a small portion thereof at any one time.

The variety of topics dealt with in the evening's discussion was thus quite as great as in previous years. The "problem" meeting has always proved one of the most popular of the session, and it seems likely to hold its place in the future.

International Illumination Congress 1931

Special Fund to be raised by The Illuminating Engineering Society

THE great event of the present year, for which preparations are already well advanced, is the International Illumination Congress, which is to be held in this country in September next.

Readers have already been informed of the Congress. Naturally such an event cannot be carried out without adequate financial support, and it is right and fitting that The Illuminating Engineering Society, to which the Congress is of outstanding interest, should share in this effort.

The following letter, issued by the President of the Society, states the case very clearly:—

Dear Sir,

I have pleasure in enclosing a programme relating to the International Illumination Congress, which is to take place in this country during September 1st-19th, 1931.

One of the results of this important Congress will doubtless be to bring about a widespread recognition of the benefits of good lighting and to raise the subject of illumination to a higher place in public esteem.

This will be the first occasion on which the Congress has met in Great Britain. The last Congress, held in America in 1928, was marked by great enthusiasm and was attended by 500 Delegates from Austria, Belgium, France, Germany, Great Britain, Holland, Italy, Japan, Sweden, Switzerland, and the United States. Many years may elapse before the Congress again meets in this country. There is a general feeling that everything should be done in a manner worthy of this unique occasion, and that our country must not fall behind others in efforts to instruct and entertain its guests from all parts of the world.

The Council of the Illuminating Engineering Society, who are acting as joint hosts with the National Illumination Committee, feel that it is incumbent upon the Society to do everything possible to aid in the preparations for the Congress and to ensure its success.

The Society has accordingly undertaken to subscribe £250 from its own Funds, as well as raising an additional amount.

I am, therefore, writing, on behalf of the Council of the Society, to express the hope that you will see your way to make a contribution to this Special Fund which the Society is raising. The occasion is an exceedingly important one in the history of the Illuminating Engineering movement, and I am sure that you will do what is possible to help the Society to carry out what it has undertaken.

Yours faithfully,

KENELM EDGCUMBE
(*President*).

We feel sure that this appeal will meet with a ready response. It is addressed especially to firms in the lighting industry that have not already contributed through other channels: but it is possible that even some of those who have already contributed may like to make a small additional donation to the fund which the Society is raising.

There can be no question but that an event such as this, which directs public attention throughout the country to the importance of good illumination, is of direct benefit to all firms in the lighting industry. We feel sure that they must recognize the obvious duty of giving aid, each according to their means, to an effort which should help to counteract the prevailing depression. Admittedly, conditions of business are difficult at the present time; but not so difficult, surely, as to furnish an excuse for not contributing to so good a cause!

We may add that *The Illuminating Engineer* has already undertaken to make a substantial contribution towards this special fund, so that example may reinforce precept!

Cheques and postal orders should be made payable to The Illuminating Engineering Society, should be crossed "A/c International Illumination Congress Fund," and should be sent to the Hon. Secretary of the Illuminating Engineering Society, 32, Victoria Street, London, S.W.1.

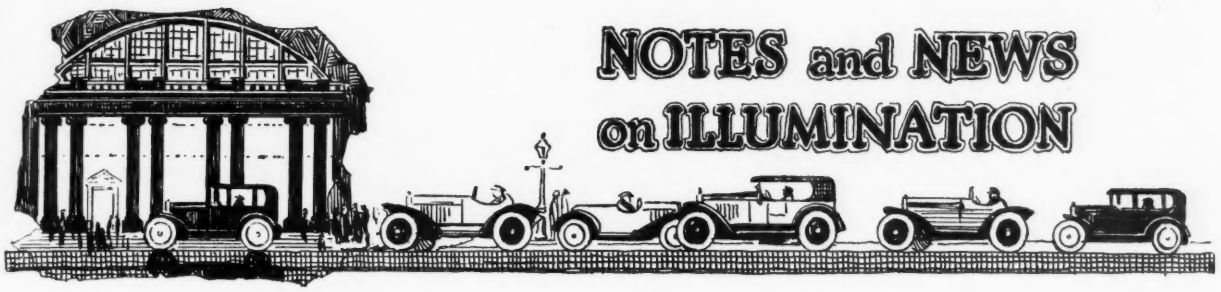
Economy—or Paralysis?

Public men, economists and financiers are apt, during such a time as this, to speak with two voices. There are those who urge on their neighbours the duty of spending, rather than hoarding, as a means of keeping the machinery of credit in action. There are others—much more numerous—who, when trade becomes difficult, seem to think that a complete remedy can be found in economy, by hoarding resources, rather than employing them in enterprising effort.

The true course, both for bodies and individuals, doubtless lies between these extremes. The most vital thing is to distinguish between true and false economy. In so far as economy means avoidance of waste, it is good; in so far as it means relaxation of effort and paralysis of enterprise, it may be very bad indeed. We cannot help feeling that much of the economy one hears about, and sees in action, savours of rather ignoble panic. One hears with some wonder of firms with many years of successful trading behind them "economizing" in research, cutting down their publicity or abandoning participation in common enterprises. Such efforts often show a strange lack of sense of proportion.

There are some economies that are justified in hard times; they may pare away ornament or eliminate superfluous effort, they do not diminish efficiency. But there are others that act like a boomerang. When a business ceases to advertise, or even slackens its propaganda, it almost invariably finds that the diminution in trade is accelerated; from the moment that effort to keep their name in the foreground ceases, they are already on the road to extinction. When experiment and enterprise have been checked, paralysis has already set in. Timid folk are apt to embark, after much hesitation, on economies at the very moment when the need for them has already begun to pass away. One hesitates to assume the rôle of a prophet; yet, in fact, there are already some indications that the worst may be over.

It is often said that hard times furnish an acid test of a man or a business. The weak, gradually abandoning effort, complainingly disappear. But really able men or organizations use the occasion to strengthen themselves; they employ the interval in clear thinking and constructive planning, and they work harder than ever; when good times return it is suddenly apparent that they have outdistanced their rivals, and emerged stronger than ever before.



Industrial Lighting

We notice that on the evening of Wednesday, April 15th, Mr. D. R. Wilson (H.M. Deputy Chief Inspector of Factories) will be delivering a lecture on "Industrial Lighting" before the Royal Society of Arts. Mr. D. R. Wilson, a Past President of the Illuminating Engineering Society, must be well known to all but very recent members, and the good work that he has done in promoting the study of factory lighting should be almost equally familiar. On such occasions he has invariably something interesting to say, and no doubt a number of members of the Society will wish to attend. We shall be glad to hear from anyone who would like tickets for this meeting. Another Past President, and an old friend of the Society, Sir John H. Parsons, is to preside.

A Novel "Little" Theatre

The recently-opened "Little" Theatre at the Alexandra Hall, Halifax, has attracted a considerable amount of interest owing to the very special nature of the lighting. One of the main features is the use of a domed cyclorama (stated to be the only completely domed cyclorama in this country), of such height that the conventional cut cloths can be dispensed with. With the exception of the footlights and spot lights there is no white-light equipment; [illegible] "white light" is required it will be produced by mixing red, green and blue. Other special features are the use of prismatic units operating on the three-colour principle, and the provision of disappearing footlights, which can be eliminated when certain types of "intimate" plays are produced. For some time the staff has been preparing for the performance of "Adam the Creator," revealing the destruction of the world and its re-creation by man—an imposing effort which will call for all the special lighting equipment provided. It is stated that, with the exception of the Festival Theatre, Cambridge, the Alexandra Hall has the only stage in this country where the special setting aimed at in this play could be arranged. We understand that the lighting equipment has been designed under the supervision of Mr. C. H. Ridge (who lectured before the Illuminating Engineering Society last year) and Mr. F. S. Aldred.

Illuminated Police

It is stated that the Prefect of Police in Paris is experimenting with a new device for rendering officers on point duty visible. The use of white gloves, sleeves and helmets, together with local floodlighting, has been of some service. Now it is proposed to attach small lamps, presumably fed by a small accumulator, to their caps. We hope that officers thus treated will not become sources of glare, and we confess that we are somewhat averse from the introduction of yet more special lights in the streets, additional to street lamps, traffic signals, motor headlights, and tail lamps. It is not surprising that the choice of colour for the lamp has been the subject of argument; on the whole, green seems to be the most popular choice.

Clearer Name-Plates in Streets

The Roads Improvement Association has been emphasizing the importance of better name-plates to indicate the names of streets. Absence of such indications, or the use of old and illegible plates, are direct causes of congestion in busy thoroughfares. There ought to be "easily readable name-plates at every junction of a long street." Standardization would ultimately be desirable; but in the meantime there are certain obvious precautions that might be observed, such as placing names on *both* sides of the streets, and between 6 ft. and 10 ft. from the ground wherever possible, and avoiding confusion with adjacent advertisements. In London there has been a considerable improvement within recent years, but the provision of name-plates seems to be still regarded as a purely local duty, so that it is difficult to enforce rules. In addition to legibility in daylight we consider that more attention should be given to the illumination of such names by night. Affixing plates in the neighbourhood of public lamps is obviously helpful. The ideal course in leading thoroughfares would be the general use of well-designed illuminated transparency-signs. Now that the use of electricity for so many subsidiary lighting effects in streets is becoming usual we do not regard this suggestion as visionary—at all events for streets of importance in large cities.

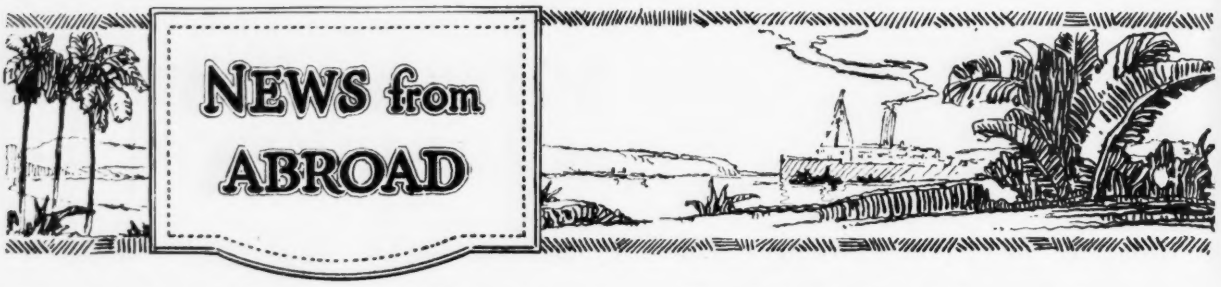
Colour Blindness and Traffic Signals

The Council of British Ophthalmologists has been drawing attention to yet another street-danger, arising from the inability of certain people to distinguish the red, green, and amber luminous signals now being introduced for traffic control. We have no positive information as to what proportion of motorists is colour-blind. It is somewhat surprising and a little disturbing to read the suggestion that as many as four per cent. may be thus afflicted. One is somewhat reassured, however, by knowledge of the adaptability of colour-blind friends who conceal their infirmity remarkably well. Some months ago we referred to an account, appearing in an American journal, of the experiences of "a dicromat" who had somewhat learned to distinguish traffic signals with very fair facility—one might almost say with certainty. The lettering of the lamps with "stop," "go," etc., is an aid, though not sufficiently evident at a distance. Perhaps the best solution is that the various colours should be associated with distinctive shapes—e.g., a circle, a square, or a triangle.

Master Signmakers' Association

SECOND ANNUAL CONFERENCE.

The second annual conference of the above Association, which took place in February last, is reviewed in the March issue of *Signs*. The opening address was delivered by Sir William Crawford, and interesting papers were read by Mr. J. M. Beable, Mr. F. G. H. Macrae and others. In the same issue of *Signs* there are several other suggestive articles, notably Mr. Langdon's discussion of the design of illuminated airway-markers, and the note on the revival of the distinctive inn-signs of the past.



Illumination and the Visual Functions

The attention of readers may be drawn to the imposing contribution of Dr. L. T. Troland, of Harvard University, to the *Transactions* of the Illuminating Engineering Society (U.S.A.).* The full title, "An Analysis of the Literature concerning the Dependency of Visual Functions upon Illumition Intensity," may seem rather alarming. When it is added that the analysis occupies nearly 100 pages, and that the sources analysed exceed 9,000, it will be understood that the task set himself by Dr. Troland is a very formidable one. The comments are presented in nine successive sections, to most of which selected sources of information are appended. Readers will find some of these sections of considerable interest, especially those dealing with the influence of illumination on acuteness of vision and industrial work. Apparently the period examined did not extend beyond 1925. But we understand that the I.E.S. Committee on Progress is to continue the critical analysis initiated by Dr. Troland, the extensions to be published at approximately ten-year periods, so that ultimately we shall get information on the period from 1926 onwards.

The Lighting of the Ermitage Museum in Leningrad

A serial article in *Licht und Lampe*, by Prof. S. Maisel and Mr. E. Jakoview, describing the lighting of the Ermitage Art Museum in Leningrad, might prove interesting to Mr. Bernard, as some of the problems resembled those he encountered at the recent International Exhibition of Persian Art. The authors, however, were allowed much more time to experiment, and were accordingly able to devise a number of original designs. Some of the trough picture lighting units seem similar to those adopted in London, but in another room containing pictures there is a somewhat unusual central ceiling fitting using a cylinder of diffusing glass approximately one metre in diameter. Another room is lighted by an apparently ungraceful but possibly efficient cluster of mirror reflectors, supplemented by screens to eliminate troublesome reflections. In other interiors, again, indirect lighting was mainly employed, and, in yet others, luminous panels, cornices, etc., were embodied in the architectural scheme with good results. There are also three views of a statue of Voltaire, illuminated by three different methods giving rise to different shadow effects.

The Predetermination of Polar Curves of Light Distribution

An analysis of lighting equipment contributed by M. Wetzel to *Lux* deals with the influence of the nature and contour of reflecting surfaces on polar curves of light distribution. One finds, even amongst lighting experts, strange misconceptions on this point, which might well form the subject of a paper before the Illuminating Engineering Society.

* Vol. XXVI. February, 1931, No. 2, pp. 107–196.

The International Commission on Illumination

Its Origin, Organization and Work.

This is the title of another booklet which the energetic Hon. General Secretary of the International Illumination Congress, 1931, has prepared. We hope that most of our readers are by now familiar with the programme of the International Illumination Congress, which takes place in this country in September next, and that many of them have already intimated their intention of attending. But it is possible that some of them may know less about the origin and present work of the International Commission on Illumination—hence this new booklet, which contains an account of its origin, a survey of its recent activities, and, in appendices, records of papers presented at Paris (1921), Geneva (1924), Bellagio (1927), and Saranac Inn, N.Y. (1928).

We will gladly arrange for copies of this booklet or programme of the International Illumination Congress, 1931, to be sent to anyone interested.

Illuminating Engineering in Japan

We have many times observed with interest, but with some perplexity, the contributions which appear in the *Journal* of the Illuminating Engineering Society of Japan, in which familiar pictures, tables and diagrams, and even names occasionally appear—but only as oases in a maze of Japanese characters. We therefore hail with pleasure the inclusion in the current issue of a page addressed "To One Who Cannot Read Japanese," which is written in English, and contains serviceable extracts of the chief contributions now published. (It is true that we are warned that the abstract may be written in English, French, German or Esperanto; but even so we shall probably be able to manage, and we retain our confidence that abstracts in English will predominate.) The contributions thus abstracted are three in number: "On the Development of the Electric Lamp," by U. Shinohara; "The Classification of Luminaires by Flux Distribution," by Z. Yamauti and K. Hisano; and "Architecture and Lighting," by K. Sato. The second of these items seems worthy of study by the B.E.S.A. Committee concerned with this problem: perhaps some of its members may feel disposed to take advantage of the friendly offer to present full translations of papers to those specially interested.

Ingenious Illuminated Signs

Some pictures are given in *Lux* of ingenious illuminated signs contrived by the celebrated Jacopozzi in connection with the Christmas shopping campaign in Paris. Amongst premises thus decorated were the Galeries Lafayette, the Bazaar de l'Hotel de Ville, and the Louvre. Apparently, in Paris, these luminous spectacles can be witnessed without the risk of enforced stoppage such as deprived many Londoners of the opportunity of seeing Jacopozzi's sign outside Gamages!

TECHNICAL SECTION

COMPRISING

Transactions of The Illuminating Engineering Society and Special Articles

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

Problems in Illuminating Engineering

(Proceedings at the meeting of the Illuminating Engineering Society, held in the Lecture Theatre of the Home Office Industrial Museum, Horseferry Road, Westminster, S.W.1, on Wednesday, February 18th, 1931.)

As reported in our last issue, a very successful meeting of the Illuminating Engineering Society was held in the Lecture Theatre of the Home Office Industrial Museum, at 7 p.m. on Wednesday, February 18th, when various "Problems in Illuminating Engineering" were presented. The President (Lieut.-Col. Kenelm Edgcumbe) occupied the chair.

The Relation between Intensity of Illumination and Visual Capacity.

The first problem, presented by Mr. T. F. H. Marsh (in the absence of Mr. W. J. Jones through indisposition), dealt with a novel form of test devised at the E.L.M.A. Lighting Service Bureau in order to trace the relation between illumination and the speed of vision of workers in offices and drawing offices. The test is conducted as follows:—

Six sheets of paper are required on which the numbers 1 to 12 are typewritten and arranged haphazard, the arrangement being different on each sheet to prevent the subject getting too familiar with the location of numbers. The test subject is required to join up, free hand, the numbers in order.

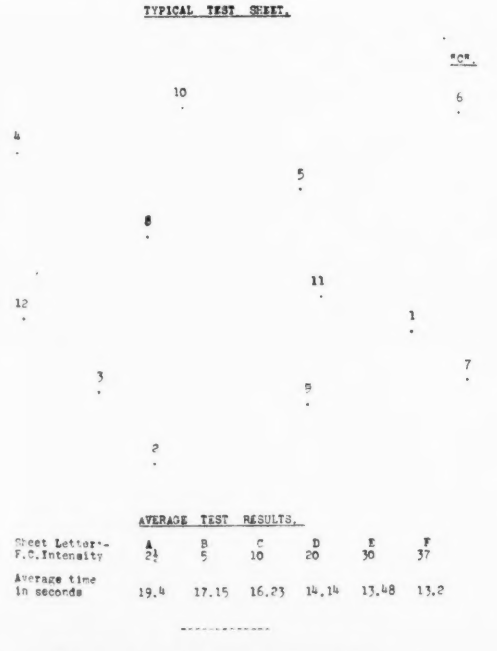


Fig. 1.—A typical Test Sheet and Results.

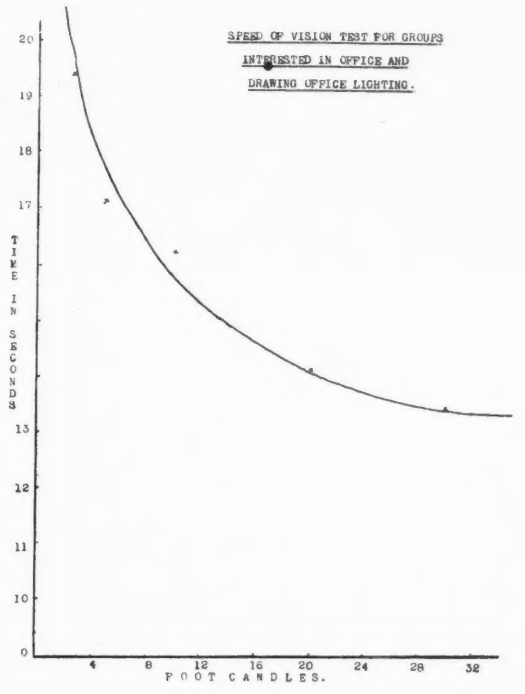


Fig. 2.—Illustrating relation between Illumination and Time occupied in Test.

The time for completing the task is taken under several different intensities of lighting. The intensities vary between $2\frac{1}{2}$ and 40 foot-candles, and each subject uses the same arrangement under any one intensity.

As a check on the accuracy of the method and to ensure that the increase in speed is due to the greater intensity rather than to the fact that the subject is becoming accustomed to the operation, the test has been checked in a number of cases starting from low and increasing to the high intensity of light and vice versa.

Fig. 1 shows a typical chart and Fig. 2 a curve illustrating the results obtained on tests taken on 18 persons of various occupations.

It will be observed that quite a regular curve relating time in seconds to foot-candles is obtained, and this serves to show the general dependence of visual capacity on illumination, though naturally the relation would vary somewhat according to the particular task undertaken.

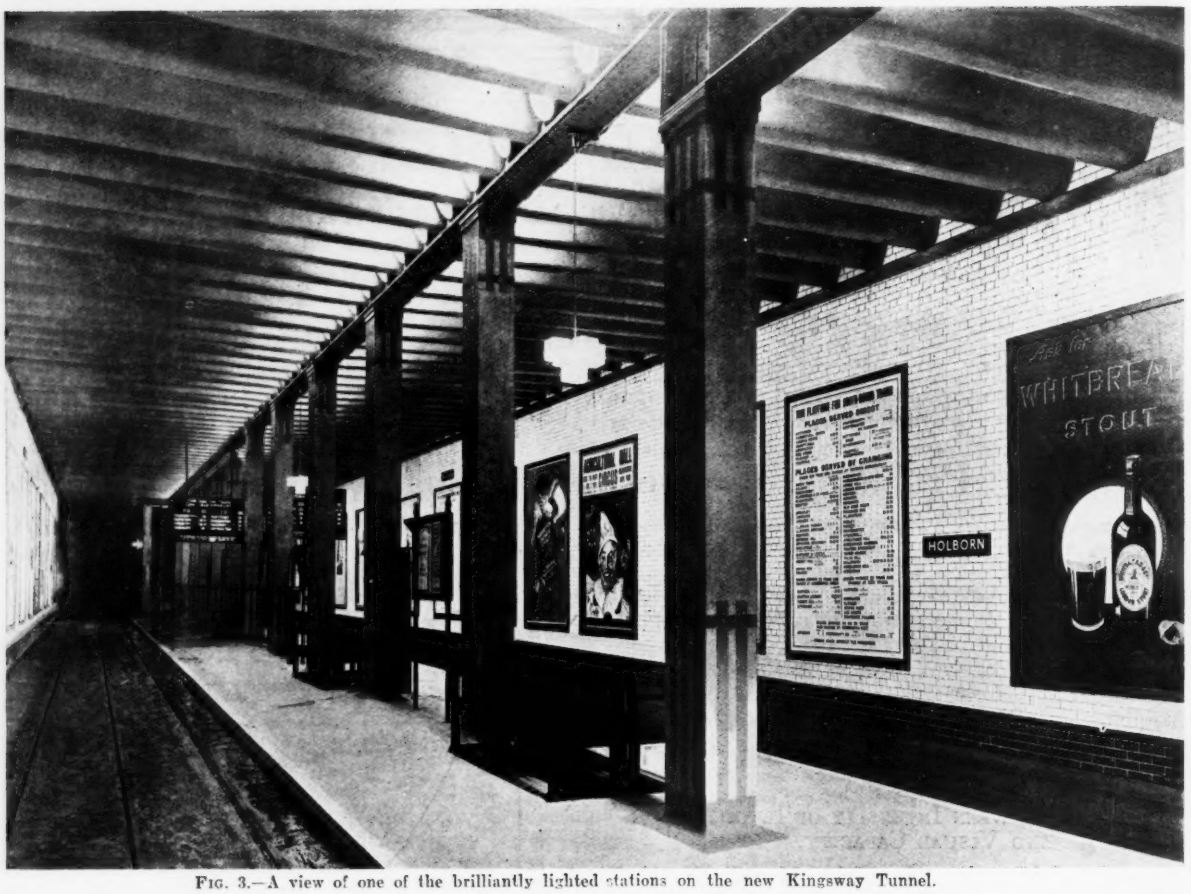


FIG. 3.—A view of one of the brilliantly lighted stations on the new Kingsway Tunnel.

THE LIGHTING OF THE KINGSWAY TUNNEL.

This novel installation was dealt with by Mr. J. H. PARKER (Electrical Engineer, L.C.C. Tramways) who explained that when the tramway subway between Southampton Row and the Embankment was deepened to accommodate double-deck cars it was decided to improve the lighting throughout its length.

The new floor and wall surfaces were finished in concrete to make a smooth, safe roadway, but it was not intended to treat the ceiling and walls specially and, therefore, mirror-reflectors were used to confine the light to the narrow elongated area occupied by the cars without depending in any way on the low-reflecting value of the roof and walls.

Reflector fittings of a familiar type, designed to collect and distribute the light over a confined area, were adopted; the illumination half-way between the lights, where it would otherwise fall to a very low standard, was thus substantially increased. Four different modifications of these reflectors were used to suit the variations in the curvature of the subway. Ultimately it was found that fittings equipped with 100-watt lamps, spaced at intervals of 100 feet, gave sufficient illumination to read by in any part of the subway. For this low consumption of 1 watt per linear foot of subway, the illumination was better than in many of the streets above ground; this result was due entirely to the manner in which the reflectors enabled the best use to be made of the available light.

For the lighting of the station platforms, advantage was taken of the channelled formation of the roof. These channels are spaced 30 ins. apart, and where they are supported by the beam in the centre of the platform small recesses are left on each side into which were installed specially designed prismatic floodlights with smooth outer cover glass.

These units take 100-watt lamps and are set at an angle of 25 degrees below the horizontal. This prevents any dazzling effect when viewed from the platform, but projects the whole of the available light on to the white-glazed side walls and coloured advertisement matter, giving a brilliant shadowless illumination all over the platforms. The lights are on three circuits, each controlling every third lamp.

As an aid to good illumination it was decided to adopt two shades of biscuit colour for the decorative treatment of Holborn Station and two shades of sea-green for the treatment of Aldwych Station. Down the centre of the platforms luminous cubical

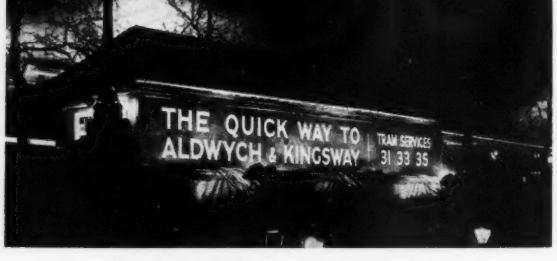


FIG. 4.—An Effective Illuminated Sign.

fittings harmonize with the general decorative effect: these were installed for stand-by lighting, and were supplied from the power companies.

At the Ministry of Transport inspection the Inspector asked for a demonstation with emergency lights. There were four of these emergency fittings on Holborn platform, each with five 60-watt lamps, but the light colour scheme of the station gave such a good reflecting effect that the Inspector reported that the stations on emergency lights only were much better lit than many railway stations.

Special Lights for Operating Staff.

The platforms are 4 ins. above the track rails, and tubular lamps behind prismatic reflectors are installed in the kerb of the platform opposite the "gate" in the conduit to throw light under the car when required to facilitate the examination of the plough. At required intervals fire appliances are provided in recesses in the subway walls, and a pair of red lamps (in parallel for liability) serve to indicate where these are to be found. On the stair-

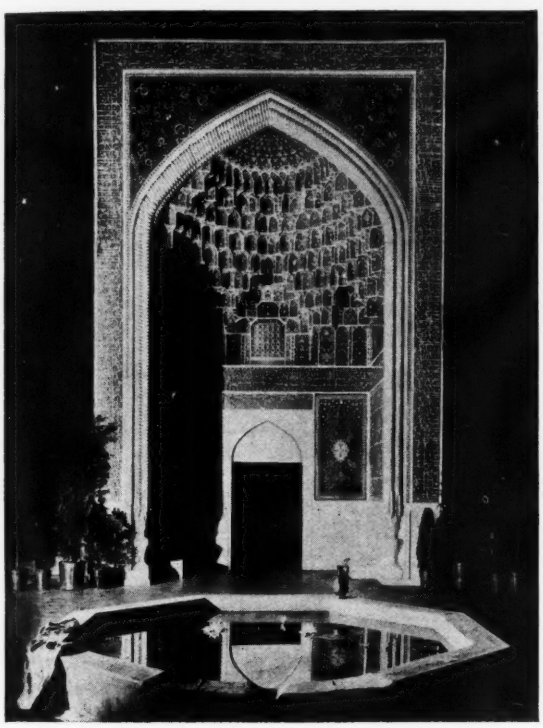


Fig. 5.—The Model of the Portal of the famous Royal Mosque, Isfahan, with pool in foreground.

ways further cubical fittings with the name of the station burnt into the faces of the cubes serve the double purpose of lighting the stairs and throwing the lettering of the indicators on the stairs into relief.

There are 210 floodlights on the two platforms.

In the subway itself there are 45 special reflector-fittings and eight sets of red lamps to indicate the positions of the fire appliances. Plug points with portables located beside them are placed at each of the eight crossovers in the tunnel, but at each cross-over a floodlight similar to those on the platform

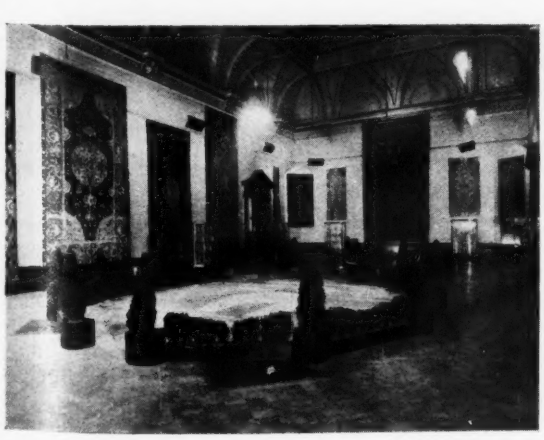


Fig. 6.—A photograph taken by artificial light showing how carpets were illuminated.

and controlled by a local switch is expected to give all the light that may be required.

Mr. Parker concluded by remarking that preconceived notions die hard, and one of them was that good lighting was expensive! The whole of the lights in the subway and platforms consumed 30 units per hour and did not cost 18 pence per hour, and as 60 trams pass through the subway each hour during the busier portions of the day the cost per car-mile was negligible. The old subway had 150 lamps instead of the 45 special fittings now installed, and was very badly lit. The difference rested in the fact that instead of allowing the light to be absorbed by the dark roofs and ceilings these fittings collected the whole of the available light and projected it just where required and nowhere else; that, he thought, was the secret of cheap and effective illumination.

Lighting of the International Exhibition of Persian Art.

Mr. Oliver P. Bernard, who had advised on the lighting of the International Exhibition of Persian Art, gave an address on this subject. He mentioned he had for long been specially interested in the lighting of theatres; had worked with electric lighting therein for 30 years, and with gas lighting even before then.

As an introduction to his discourse Mr. Bernard read an extract from an article criticizing the lighting of the Exhibition. (Mr. Bernard seemed to be under the impression that these comments had appeared in the *Journal* of the Society, but, on the intervention of the President, it was ascertained that this was not the case!). The criticism described the scheme of lighting as inadequate, taking into consideration the nature and incalculable value of the treasures displayed; in the majority of cases, it was suggested, the finer details could not be perceived —as was proved by a minority of exhibits that *were* well illuminated.

Mr. Bernard remarked that this criticism was concerned simply with "adequacy." But adequacy in the technical sense was only the beginning of the problem. Distribution, order of illumination, and other physical aspects must be studied. But behind that there was the dominant question of the psychological effect.

The lighting of this exhibition was essentially a psychological problem rather than a scientific one. One had the choice of treating it either as an exhibition or as a museum. A museum existed primarily to display objects to people with special interest therein; in such a case it might well be argued that the expert wanted merely to see things "as they really are." But in the case of an exhibition for the general public the problem was somewhat different. Of the thousands expected to visit the Persian Art Exhibition it could safely be predicted that only a minute minority could be considered authorities on Persian Art. It, therefore, seemed necessary to make an appeal to the uninstructed majority—to make the lighting of the exhibition attractive rather than precisely accurate. He (Mr. Bernard) when asked to advise felt that an element of showmanship, a certain sense of drama, should be introduced.

Carpets were a main feature in this exhibition. Well, one could see excellent displays of carpets, adequately illuminated, in the Tottenham Court Road! It was a question whether these large Persian carpets, in many cases as much as 40 ft. long and 15 ft. wide, could be "adequately" illuminated without the lantern becoming more conspicuous than the object—whether, also, it was desirable to reveal every detail in the pattern and texture of the carpet or to render it an impressive

and pleasing object as a whole. When a carpet was one of a great number having various predominant colours, it added to the effect if one selected the colour of the light so as to embrace the main colours in the carpets—producing a sense of drama very different from that existing in the ordinary showroom. He did not think, however, that the coloured screens employed would prevent analysis of the designs and colours. But they did help to illuminate the wonderful beauty of the objects from the psychological point of view.

In conclusion Mr. Bernard remarked that, in judging the adequacy of the illumination, it should be remembered that the work was undertaken within a week of the opening of the exhibition; there was, in fact, less than a week in which to decide what should be done, and the whole of the work was done in practically 48 hours. From the commencement it was understood that there were limits to the expenditure on lighting—which, incidentally, were exceeded! He hoped that Mr. Belshaw, who was responsible for the actual carrying out of the work, would have something further to say in the course of the discussion.

Lighting for Furniture Spraying.

Mr. Harold Long, in introducing his subject, remarked that modern methods of production demanded modern lighting, and he described an interesting solution to a problem having special limiting requirements.

Fig. 7.—General view of Special Reflector.

He explained that the use of cellulose finish is becoming very popular, and it is now being applied, particularly in the clear form, to furniture, the finished surface being more uniform and durable than the surface produced by the old methods.

In the particular case under discussion, the furniture to be sprayed travelled on a moving belt through the spraying booths, and it was therefore essential that the operatives should be able to see every detail with the utmost speed so as to avoid leaving any blemishes on the surface. This condition not only necessitated the use of a high intensity of illumination, but one of a corrected colour value so as to approximate to daylight. In addition, it was necessary for the illumination to be furnished from the correct angle in order to prevent reflected images of the fittings; moreover the light, whilst accurately controlled, should be sufficiently diffused to avoid deep shadows and to eliminate any possible reflected glare which could not be overcome merely by providing the best direction of light.

In order that the feet and lower mouldings of the furniture might receive an illumination equal to that of the upper parts, the distribution of light from the fitting had to be such as to provide a maximum candle-power at the furthest distance therefrom. The Home Office requirements necessitate the use of a fitting which is vapour-proof.

Summarized, it would be seen that the limiting conditions in this problem were intensity, colour-quality, direction, diffusion quality, distribution and vapour-proof qualities.

The illustration (Fig. 7) shows the reflector specially developed for this work. Mr. Long stated that this light unit, when used with daylight-blue lamps, answered all requirements. The reflecting surface was chromium-plated in order to obtain accurate light control, and the lens front further controlled the light into sheet formation. A vapour-proof adjustable knuckle was provided so as to obtain accurately the best angle for the direction of the light, and particularly in order to ensure that the maximum candle-power is directed to the lowest point of the work.

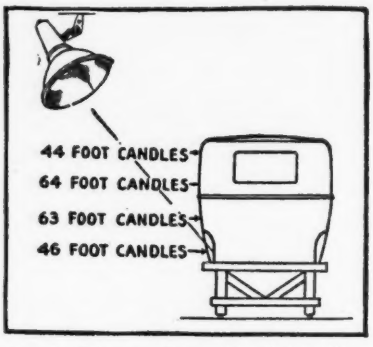


Fig. 8.—Diagram illustrating Distribution of Light

The diagram (Fig. 8) shows the results obtained in practice where this fitting was used for cellulose spraying of the coachwork of the motor cars; this being a kindred problem to that under discussion.

Unfortunately, illustrations of a large installation in the furniture industry were not obtainable, but a very successful installation had been carried out with approximately 100 lighting units of this type in use.

The Floodlighting of the Singer Sewing Machine Co's Building.

Mr. R. A. Ives then discussed the above problem. He mentioned that the building under consideration stands in a commanding position in the City Road, Finsbury, E.C., and forms a good subject for floodlighting, being an outstanding feature at night visible over a considerable distance. It is surmounted by a dome, minaret and spire, the height from ground level to the top of the spire being approximately 120 ft. With regard to the dome, this has a diameter of 22 ft., whilst the minaret is 7 ft. diameter by 20 ft. high to the spire.

The scheme dealt with the floodlighting of the façade on the corner elevation facing towards Finsbury Pavement at the junction of City Road and Tabernacle Street.

Fig. No. 9 shows a night photograph of the building with floodlights concealed on the balcony throwing the two columns into silhouette, and to achieve this result four 500-watt projectors are installed. Above the balcony recess on the 6th floor the floodlighting effect is obtained by a battery of 47 120-watt weatherproof trough reflectors: the troughs are located on the stone coping, being entirely concealed from view by daytime, and equally so at night.

Mr. Ives explained that the floodlighting below

FIG. 9.—A Night Photograph of the Singer Building, partially floodlighted, throwing two columns into silhouette.

the dome portion of the building does not represent any real difficulty; the real problem arises when considering floodlighting of the dome. Here, apart from the usual difficulties experienced in lighting a dome, such as spill light and the elimination of shadow zones, particularly near the top of the dome, it was found extremely difficult to obtain sufficient projection distance to obtain ideal results.

Efforts were then made for permission to install a battery of floodlight projectors on the adjoining buildings, but the idea was abandoned owing to various difficulties which arose. Finally, it was decided to make the best of it with the existing locations available at the base of the dome, at the same time keeping in mind the importance of accessibility from the point of view of maintenance.

It was chiefly desired to illuminate half the surface of the dome and minaret to complete the scheme of floodlighting. (The other half of the dome is partly obscured from the line of vision by intervening buildings, but is still under consideration.) The floodlights were located at the base of the tower in the position shown in roof plan (Fig. 10), and

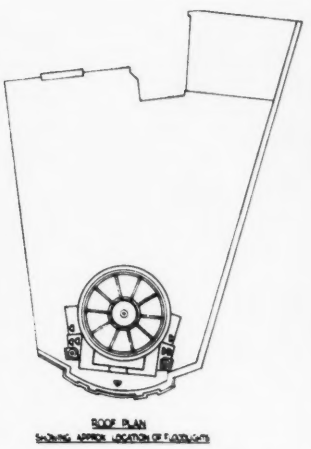


FIG. 10.—Roof Plan showing location of Floodlights at the base of the Tower.

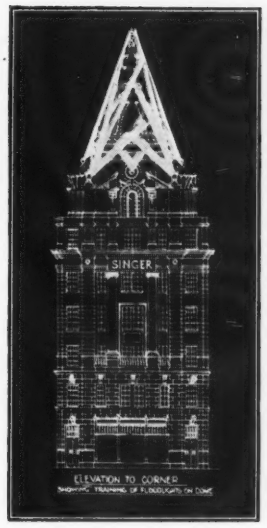


FIG. 11.—Elevation of Tower.

theoretically the beams were to be trained as indicated in elevation diagram (Fig. 11).

In practice, however, it was found to be a very hazardous task to train the floodlights owing to the almost inaccessible position and the very limited space available at the base of the tower. In the front of the dome no available position could be found for housing floodlight equipment, also it was considered undesirable to have brackets, etc., marring the architectural features of the building during the daytime. A room in the interior of the dome with a small round window opening into it was, therefore, utilized to house a floodlight which would be concealed during the daytime, and easily put in operation at night.

This floodlight is mounted on a specially designed bracket, which is supported on roller bearings attached to a substantial metal framework, the whole equipment being well balanced, and it required but very little effort to run the bracket out through the window opening, obtaining a projection distance of approximately 6 ft. from the front of the dome to the axis of the floodlight projector. The beam divergence and training must, of course, be predetermined. Fig. 12 shows the bracket and floodlight safely housed in the interior of the dome. Fig. 13 shows a view of the window opening of dome, showing the bracket and floodlight in the operating position.

The types of floodlight projector used throughout the scheme (see Fig. 14) were equipped with

FIG. 12.—Showing Bracket and Floodlight in position.

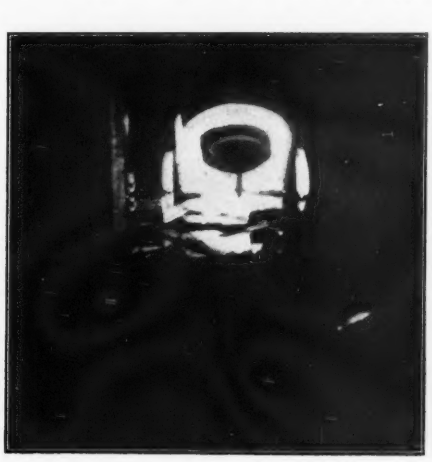


FIG. 13.—Another view of Bracket and Floodlight seen through window opening in Dome.

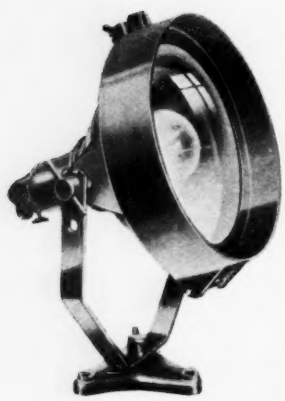


FIG. 14.—A general view of a Floodlighting Projector.

1,000-watt lamps. In general these projectors are constructed with a cast-iron housing, etc. An exception has been made, however, in the case of the unit on the adjustable bracket; here the housing has been specially made of light aluminium alloy.

Fig. 15 is a night photograph showing the floodlighting of the building, including the dome and minaret.

In conclusion, Mr. Ives stated that further developments are pending with a view to obtaining the most perfect floodlighting results possible under the conditions. He hoped that his colleague, Mr. E. T. Barker, would give his experiences with regard to the actual training of the floodlights, which presented special difficulties, and on which much time had been spent. The projectors were at the extreme edge of the stonework; in most installations the projector can be operated from the rear of the beam; in this case the adjustment had to be effected from in front. One had to lie in a cramped position in order to avoid the dazzle and prevent one's shadow interfering with the effect.

In the case of the projectors located behind the stone ornaments, only about 3 ins. clearance was available in which to make the necessary adjustments. In training the floods, pre-arranged signals were given by an observer located at a suitable distance, and the glare to which the operator's eyes were exposed made recognition of signals difficult. Moreover, some alterations in side projectors affected the performance of those in front and vice versa.

Yet another difficulty arose on the first night of operation. When the operator wished to descend the intense upward beam made it impossible to pick out the foothold, and a false step would certainly have meant his absence for the next evening's work! It was many minutes before he could get down to comparative safety. Prior to the next night, a special water-tight fitting was installed to bring out the edges of the masonry in strong relief.

The Lighting of a Large Warehouse.

The final item on the programme was a description by Mr. G. W. Golds of the lighting of a large warehouse, used for paper storage, which was 264 ft. long and 102 ft. broad, and having a floor area of 26,928 sq. ft.

The warehouse in question, Mr. Golds, explained, is used for the storage of rolls of paper 5 ft. long and 3 ft. diameter, weighing approximately half a ton each, and they are sometimes stored in two tiers; no fixed gangways are used, as the paper is brought in and out as the various firms require it and space

FIG. 15.—Final Night Photograph showing Floodlighting of the whole Building, including Dome and Minaret.

does not permit special positions for each firm. The roof is carried on girders which are only 6 ft. 8ins. from the floor, the roof rising V-shape between these girders is also interlaced with heavy wooden beams. The lighting is required for reading labels attached to the rolls and may be required at almost any spot in the warehouse for a short period only.

The floor space could be lighted quite well by the use of fixed points, but the number required to do this in a satisfactory manner would be very considerable and, in order that waste of current should not take place, not more than two points should be controlled by one switch. This would involve heavy installation costs and it would be very difficult to arrange for the switches to be in accessible positions. Under these circumstances it was decided to try some form of travelling light which could be moved to the position required and would remain in that position, until required somewhere else. After careful consideration the following arrangement was considered suitable both for the reason of first cost and future maintenance.

Ten straining wires are arranged the full width of the warehouse and supported at a central point, and two travelling lights consisting of a metal frame suspended from each straining wire by a brass bush (a wheel in place of the bush would possibly become fixed and cause trouble), each of which would slide along the wire from one wall to the central support; these fittings are connected through cab-tyre cable to an automatic reel, which takes up the slack or pays out more cable as the fitting is pulled along the wire. This reel is fitted with a ratchet, so that when the fitting is at rest the tension on the cable is released.

The fitting is quite a simple affair, which consists of a tube drop, a lamp holder, and a suitable insulated handle below. The man operating this holds the handle and walks to where he requires the light, operates the ratchet as he would on a roller blind, and the lamp remains in that position until moved again.

With this arrangement the whole of the area is well covered with a minimum number of points.

Discussion

The PRESIDENT, in opening the discussion, said that the contributions had been both varied and interesting: they illustrated the wide range of problems that the illuminating engineer was called upon to solve. He would call upon Mr. Belshaw, whose name had been mentioned by Mr. Bernard, to make some remarks on the lighting of the Persian Art Exhibition.

Mr. M. BELSHAW confirmed what Mr. Bernard had said in regard to the short time available for studying the lighting of the exhibition before the work was commenced. He added that there was also a very definite limit to the wiring capacity, and that the knowledge of the current consumed had a very considerable influence on the minds of the authorities! There was naturally anxiety regarding the financial success of the exhibition and the influence of illumination on "gate money." Recognizing, as Mr. Bernard had said, that the great majority of visitors would know little about the exhibits, it was thought expedient to present them in as attractive a manner as possible. It had, in fact, been said that the lighting would make or mar the exhibition; judging by results it must be admitted that the lighting was successful. The primary consideration was to please the public and it was very important to achieve this result. Many Americans who had lent beautiful things came over specially to view the exhibition, and they were naturally keen to show how their own contributions were displayed. He understood that experts had admired the lighting arrangements. The critical article quoted by Mr. Bernard had recommended the authorities of the Royal Academy to instal a good permanent installation. He might mention that the original installation was put up in 1888 and was altered in 1928. The Academy was now lighted, under ordinary circumstances, with 300-watt lamps in totally-enclosed lighting units. But the problem was not merely one of lighting pictures. The Academy was used for various purposes, and for social functions much more than was generally realized. In conclusion, Mr. Belshaw exhibited an instantaneous photograph, taken by the ordinary artificial light at the Academy banquet, at which he was present on the first occasion when the new lighting was put in. The photograph was quite good and furnished some indication of the nature of the lighting.

Mr. S. C. CLIMPSON expressed his interest in Mr. Long's contribution. Apparently semi-corrected colour values were used. One would like to know the exact value of the high intensity of illumination mentioned by Mr. Long.

Mr. H. H. LONG said that the 300-watt lamps were mounted at distances apart of about 24 in. The illumination on the actual work was of the order of 40 foot-candles.

Mr. J. S. DOW dissociated himself from the criticism of the lighting of the Persian Art Exhibition (which had not appeared in *The Illuminating Engineer*). He himself had visited the exhibition and agreed with Mr. Bernard that the effect of the tinted light was striking and that it enhanced the appearance of the carpets; this was one case where faithful reproduction of daylight-value of colours was not necessarily desirable. Apart from the effect of the lighting he thought that the "works," in the form of rather hastily assembled lighting equipment, were too much in evidence; but this was not the fault of Mr. Bernard, but of the authorities who apparently only called him into consultation at a late stage.

Mr. Dow expressed his interest in the lighting of the Kingsway Tunnel, which he had recently visited. The effect of the original lighting of the stations was quite striking as one approached them in the tunnel. He did not quite follow the object of the additional cubical fittings mounted over the platforms.

Mr. J. H. PARKER explained that these were emergency fittings which only came into operation in case the tramway current failed. They were run off a separate company supply.

The PRESIDENT suggested that the curve exhibited by Mr. Marsh would be better understood by non-technical people if the speed at which the work was done (i.e., the reciprocal of the time occupied) were plotted. This would apparently yield almost a straight line. The data seemed to suggest that by increasing the illumination from 2½ to 20 foot-candles a 50 per cent. increase in the speed of doing the work was obtained.

He noticed that several speakers had referred to "intensity of illumination." He understood that this was now an incorrect expression as the word "intensity" had now been reserved for candle-power.

Mr. H. H. LONG emphasized the importance of actual practical tests. It was difficult to convince people without an actual demonstration on the spot. The work done by the Bureau was exceedingly valuable, but even this only scratched the surface; the great majority of people who needed demonstrations did not attend lectures.

He himself had been struck by the misuse of the word "intensity." He thought that illumination should be treated in terms of flux density, in the same manner as magnetic flux.

Mr. J. ECK, referring to the tests described by Mr. Marsh, remarked that after all the work of the illuminating engineer centred round visual capacity. He would like to know, however, in what manner the illumination was varied. Were the lights "dimmed," in which case there would be variation in the colour of the light? If the colour had varied materially this might influence the shape of the curve. Some eyes were much more sensitive than others to slight variations in illumination. He would like to know whether any variation had been observed as between direct current and alternating current lighting circuits?

Mr. MARSH expressed his interest in the idea of making demonstrations to people in their offices. It seemed feasible to contrive a portable equipment, using local lighting to enable such tests as he had described to be made anywhere. In regard to Mr. Eck's enquiry the colour of the light had been constant, the number of lighting units being changed in order to vary the illumination and without dimming. No comparative trials with direct and alternating current had been made.

Mr. H. C. WHEAT enquired whether the travelling stage used for the spraying of furniture was on the ground level or above it.

Mr. LONG replied that the moving belts were about 6 ins. above floor level throughout the factory.

Mr. WHEAT suggested that in these circumstances the body of the operator might come within the beam and cast a shadow on his work.

Mr. LONG explained that this difficulty was overcome by two methods, in the first place by adjusting the height of the unit, and in the second place by using so many lighting units that the blockage of light from one of them had relatively little effect.

The PRESIDENT, in winding up the discussion, remarked that they had all learned a great deal. He proposed a cordial vote of thanks to the authors, which was carried with acclamation.

The Art of Illumination*

I.—The History of the Art

By John W. T. Walsh, M.A., D.Sc., M.I.E.E.

Introduction.

EVER since the dawn of history man has sought to lengthen his day by the use of some artificial illuminant. It is only within a comparatively few years, however, that the sources of artificial light available have been so improved that a new branch of applied art has been born, viz., the art of illumination. In fact this art is so very new that it is only just beginning to receive recognition outside the circle of those intimately associated with its development. Architecture has, for many centuries, been universally recognized as one of the leading branches of applied art. Yet the difference between the cave of the prehistoric man and a very fine specimen of modern domestic architecture is no greater than the difference between the feeble and flickering light to which our great-grandparents were accustomed and the well-planned lighting systems which are now coming into use wherever the possibilities of the art of illumination have been realized.

It is remarkable that nearly all the improvement in our sources of artificial light has taken place within a little over a century. Lamps burning animal or vegetable oils of various kinds were used almost from prehistoric times. The bowl which contained the oil had a round hole in the top for replenishment, a spout or nozzle to contain the wick, and, generally, a handle to enable the lamp to be carried conveniently from place to place.

It seems probable that the lamp had come into general use for domestic lighting in Greece by the 4th century B.C., and no doubt it had been used long before that time in temples and other public buildings. In fact, there is in Mr. Johnson's remarkable collection of lamps one of red clay ornamented with concentric circles, a characteristic of decorated pottery of the pre-dynastic period in Egypt, i.e., before 3,200 B.C. Naturally the later lamps, Etruscan, Roman and Greek, were more elaborate in design and ornamentation. Some had spaces for two or more wicks, and some were made in various fantastic shapes. A gold lamp at the Acropolis at Athens burnt day and night for a whole year with a single filling of oil. Nevertheless, during the whole of this long period of time, and for centuries afterwards, the principle of the oil lamp remained exactly the same. In fact, the only notable development in lighting devices which took place before the eighteenth century was the introduction of the candle.

Candles.

There are, of course, repeated references to candles in the Old Testament and a chandler's apparatus was found at Herculaneum. Most of us remember from our school-days the story of Alfred's use of candles for time-keeping. Wax and tallow were the only materials used, and the wicks had to be snuffed at regular intervals to prevent smoking. The introduction of paraffin wax about 1850, and the invention a few years previously of the plaited wick which bent over as the candle burned and so was self-snuffing by combustion, effected a great improvement as regards the convenience of the candle for general use.

It is interesting to note that as late as the beginning of Queen Victoria's reign the debating chamber of the House of Commons was still lit entirely by wax candles, and when it was proposed to substitute gas the answer given, in no uncertain terms, was: "Do what you like for the acoustics and ventilation, but take it as a fixed and settled point that wax candles remain."

Candle-making is still an important industry, and the truth is that for many purposes the candle is a very suitable source of light. Even in domestic lighting, as, for instance, in the dining-room, a diffused general illumination of low intensity, supplemented by the light from a number of candles in multi-branched candlesticks, gives a delightful effect not otherwise obtainable.

The Oil Lamp.

We now come to what may, perhaps, be regarded as the first step in the evolution of the art of illumination, viz., the introduction in 1784 of the Argand lamp. This lamp burnt colza oil, and had a glass chimney and a central air tube so that the flame was plentifully supplied with air both inside and out. Argand's lamp was largely used by Rumford, one of the founders of this Institution and the inventor of the photometer known by his name. Rumford was, in fact, the first illuminating

FIG. 1.—Count Rumford.

engineer, for the letter to the Royal Society in which he describes his photometer begins as follows:—

> "Being employed in making a number of experiments to determine, if possible, the most economical method of lighting up a very large workhouse, or public manufactory, which had been erected in the suburbs of Munich under my direction, a method occurred to me for measuring the relative quantities of light emitted by lamps of different constructions, candles, etc., which is very simple, and which I have reason to think perfectly accurate."

The Argand lamp held the field as the most efficient oil lamp for a considerable time, but the introduction of kerosene about 1860 brought about another marked improvement. The "duplex" lamp, in which two parallel wicks are used side by side, is probably familiar to most of us, while the Veritas lamp, in which Argand's principle of a central draught is incorporated, uses a circular wick and is a very efficient source of light. In fact, the

* Delivered January 20th, 1931. Abstract of the first of a series of three lectures before the Royal Institution.

only improvement which has been made in oil-burning lamps for domestic use since the introduction of the Veritas is the production of the paraffin-vapour lamp employing a mantle of the same general character as the gas mantle.

Gas Lighting.

It is curious that only a very few years elapsed between Argand's invention and the production by William Murdoch in 1792 of the first lighting system employing coal gas as the source of energy. Golden Lane, London, was lighted by gas in 1807, and Pall Mall two years later. From this time onward gas lighting extended with great rapidity, not only in London and in this country but all over the world. Needless to say, many improvements were introduced from time to time, but it was not until nearly the end of the last century that the system of gas lighting as we know it to-day made its appearance. For a long time the German chemist Auer von Welsbach had been experimenting

FIG. 2.—Auer von Welsbach.

with the object of producing a body which, when raised to incandescence by the heat of the gas flame, would glow intensely and form a more efficient source of light than the gas flame itself. His perseverance was rewarded, and in 1883 the first gas mantle was introduced. Mantles were, at first, exceedingly fragile, but in course of time the various drawbacks to their use were overcome, and the mantle as we know it now was evolved. The only important changes which have taken place in recent years have been the introduction of the inverted burner for ordinary domestic and general use, and the development of the high-pressure system for such purposes as street lighting, shop and factory lighting, and similar installations. The modern gas lamp is a highly efficient light source, and the ingenuity of gas engineers has endowed present-day gas lighting with a convenience and flexibility undreamed of not many years ago. Distant control is now quite common, while table lamps and pedestal lamps are available for general use. The necessity for free supply of air to the burners imposes a restriction on the design of indoor lighting systems, but for such work as street-lighting this is no disadvantage at all. High-pressure gas, in fact, is used for lighting many of the main thoroughfares both in London and in the provinces.

The Electric Lamp.

It is a curious fact that the closing years of the 19th century witnessed both the first use of gas lighting on a practical scale and the first public appearance of the electric light. For it was in 1800 that Sir Humphrey Davy demonstrated in this Institution the production of the electric arc between two rods of carbon. This, however, was only a laboratory experiment, and it was not until nearly half a century later that the arc lamp became a practical source of light. In 1855 Duboscq's lamp was shown at the Paris exhibition, and in the following year it was used by Prof. Tyndall in his lectures on light and colour given in this theatre. From that time improvement was rapid, and the famous Jablochkoff candle was introduced in 1876. Arc lamps in their many forms are still widely used to-day, and anyone who is familiar with the streets of the city of London after dark will have a good idea of what can be done in the field of public lighting by means of the electric arc.

The fact that the arc is usually a unit of comparatively high candle-power renders it generally unsuitable for domestic use, and for many years the problem of "sub-dividing the electric light" exercised the minds of electrical engineers. The solution was found almost simultaneously in this country by Sir Joseph Swan, and in the United States of America by Mr. Edison. In 1878 Swan exhibited the first filament lamp at Newcastle-on-Tyne. It consisted of a carbon filament made from parchmentized paper and enclosed in an evacuated glass bulb. Two years later, in 1880, many of the

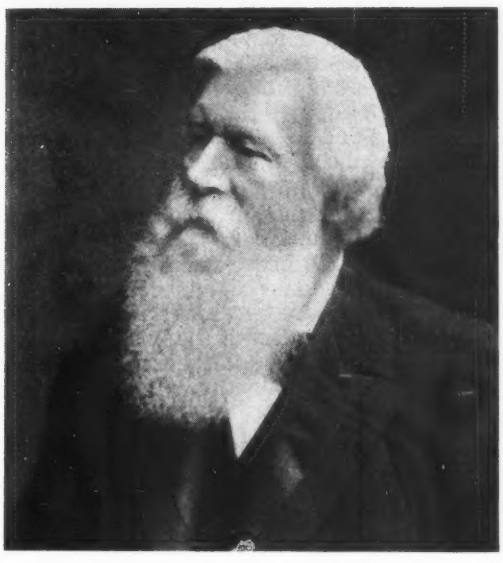


FIG. 3.—Sir Joseph Swan.

difficulties at first encountered had been overcome, and in 1886 lamps were being made in this country capable of operating at an efficiency of about 4 watts per candle, i.e., about 2.5 lumens per watt.

From this time onward the electric lamp has been steadily and continuously improved. First of all the carbon filament was improved by special treatment, giving the Gem lamp operating at an efficiency of about 3.5 to 4 lumens per watt. Then came the tantalum lamp with its filament composed of metallic tantalum. Finally, the introduction of the tungsten filament marked the beginning of the final epoch in the development of the electric incandescent lamp.

The drawn tungsten filament, when operated in a vacuum, gave an efficiency of about 8 to 9 lumens per watt, but just before the Great War a further great step forward was made by placing the tungsten filament not in a vacuum but in an

atmosphere of chemically inert gas such as nitrogen or argon.

The excessive loss of heat by convection is overcome by winding the filament into a very close spiral. The effective diameter as far as gas convection and cooling are concerned is then the diameter of the spiral, and in this way a lamp of much higher efficiency than the old vacuum lamp is obtained.

The fineness of the spirals used for the filaments of quite ordinary lamps, such as those used for domestic lighting, is quite remarkable. For instance a 200-watt 240-volt. lamp has 77 mm. of tungsten wire 0.066 mm. in diameter. This wire is coiled into a spiral of 780 turns with a pitch of 0.1 mm. and a diameter of 0.35 mm. The gas employed in the bulb of such a lamp consists of a mixture of nitrogen and argon in the ratio of about 1 to 4, the gas-pressure when the lamp is cold being about 5-7ths of an atmosphere. The efficiency of such a lamp is about 13 lumens per watt, as compared with about 9.5 lumens per watt for a vacuum lamp of similar rating. For lamps of larger sizes the efficiency is considerably greater. For the 1000-watt, 240-volt lamp, for instance, it is about 17 lumens per watt.

The variety of lamps now made is enormous. What is generally known as the "normal" type lamp is the lamp of the kind generally employed for interior lighting, for street lighting and similar purposes. The power consumed by such lamps ranges from 15 to 1500 watts. Then there are lamps specially designed for use in trains or trams. Other special lamps are made for use in omnibuses, in automobiles, or in a miner's hand lamp. At the other end of the scale are the large lamps used in projectors for floodlighting the landing grounds of aerodromes or for lighthouse work. Lamps consuming 3, 5 and 10 kilowatts, and giving candle-powers up to 20,000, or more, are now regularly employed for such purposes.

The most recent modification in the design of ordinary service lamps is the introduction of internal frosting. Ordinary straightforward etching with hydrofluoric acid is quite unsuccessful, as bulbs treated in this way are exceedingly fragile. It has been found, however, that if the bulb is treated first with a fairly strong acid solution to produce a well-etched surface, and then with a weaker solution, the effect of the latter is to restore the strength by altering the nature of the frosted surface. The loss of light, due to the treatment of the glass bulb in this manner, is very small indeed, probably not more than one or two per cent., and it is probable that the use of lamps obscured in this way will become almost universal for ordinary lighting purposes within a very short time.

Discharge Lamps.

Although the electric filament lamp has only just celebrated its jubilee, it seems as though a serious rival in the field of electric lighting has already appeared in the form of the luminous discharge lamp. Such a lamp is shown in fig. 4. The filament at the lower end heats a cylinder coated with a material having a high thermionic emission. The stream of electrons emitted from this cylinder travels towards the iron anode placed near the top of the bulb, and so starts an arc in the gas, which fills the bulb at a low pressure of the order of 2 mm. of mercury. This arc forms the source of light, and its colour is governed by the nature of the gas within the bulb. By means of a specially designed auxiliary circuit, such a lamp can be made to operate on an alternating current supply. The efficiency is at present approximately the same as that of the ordinary gas-filled tungsten filament lamp, but the

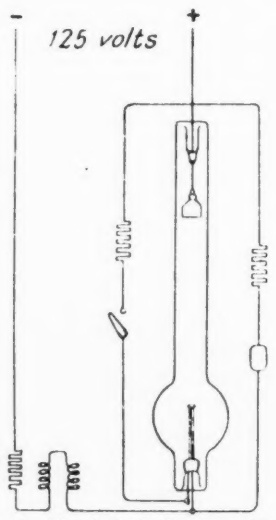


FIG. 4.—Hot Cathode Discharge Tube.

discharge lamp is at present in its very early infancy, and how it will develop remains to be seen. There is no doubt whatever that, quite apart from the matter of efficiency, the discharge tube has a very important future in front of it for many lighting purposes.

Conclusion.

This brief sketch of the wonderful developments which have taken place in sources of light, principally within the last 130 years, may perhaps give the impression that modern lamps are highly efficient light-producing machines. Unfortunately this is very far from being the case. The best type of high-pressure gas lamp will give about 53,000 lumens per therm per hour. By far the greater part of the energy produced in the combustion of the gas is dissipated in the form of heat. If all that energy could be converted into white light, i.e., if the emission from the lamp could be entirely confined to the visible spectrum, and could be equally distributed throughout that spectral range, the light given per therm per hour, would be about 5,800,000 lumens, or over 100 times the amount now actually obtainable. Similarly, the most efficient filament electric lamp gives about 25 lumens per watt, or only about one-eighth of the 200 lumens per watt which could be obtained from a source giving an equi-energy spectrum within the limits of the visible range of wave-lengths.

However, there is no doubt that the stage has been reached at which light is so cheap that it is no longer necessary to use every device for concentrating all the available light on to the point of work. The beauty of daylight, quite apart from its colour, is its abundance and the degree to which it penetrates everywhere, even under the most adverse conditions. An equal abundance of artificial light is not, perhaps, ever to be expected, but, on the other hand, considerations other than those of the most economical utilization can now take their proper place. Light can be used for a purpose for which it is eminently suitable, viz., the production of effects which please the eye and the increase of our comfort and pleasure in life after day is over. So long as economy was the dominant consideration, illumination was a branch of engineering practice pure and simple, a matter to be governed by the slide-rule and tables of constants. To-day illumination can rightfully claim its place among the useful arts. The modern designer of illumination systems must be at least as much an artist as an engineer. Like the architect, he aims to make the material in which he works achieve its utilitarian purpose in

a way which shall be pleasing to the eye. In other words, this present age has seen the birth of a new art, which may be well described as the art of illumination.

In conclusion, I should like to quote a few lines which seem to me peculiarly apt to this occasion. A few weeks ago in this theatre, Prof. Tyndall was delighting his youthful audience as he explained to them the mysteries of the electric spark. Just 70 years ago, that great man of science Michael Faraday, whose name is so intimately associated

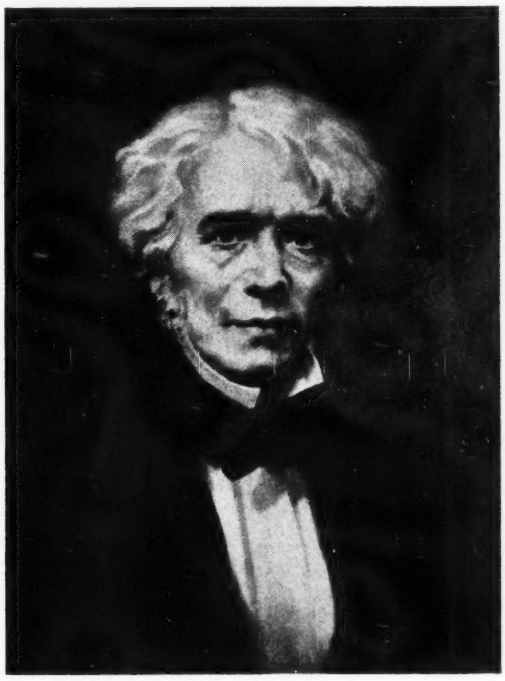


FIG. 5.—Michael Faraday.

with this Institution and the centenary of whose most fruitful discovery we shall join in celebrating in a few months' time, gave at this self-same table his famous course of children's lectures on "The Chemical History of a Candle." Sir William Crookes, in his editorial preface to the first printed edition of these lectures, wrote as follows:—

> "From the primitive pine-torch to the paraffin candle, how wide an interval! between them how vast a contrast! The means adopted by man to illuminate his home at night stamp at once his position in the scale of civilization. The fluid bitumen of the far East, blazing in rude vessels of baked earth; the Etruscan lamp, exquisite in form, yet ill adapted to its office; the whale, seal, or bear fat, filling the hut of the Esquimaux or Lap with odour rather than light; the huge wax candle on the glittering altar; the range of gas lamps in our streets—all have their stories to tell. All, if they could speak (and, after their own manner, they can), might warm our hearts in telling how they have ministered to man's comfort, love of home, toil, and devotion."

As we read the words "the means adopted by man to illuminate his home at night stamp at once his position in the scale of civilization," we may, perhaps, be pardoned a thrill of pride as we look at the tremendous strides which have been made since those words were written. This pride in the achievements of the immediate past may well give place to a thrill of expectancy as we realize all that is being done to-day to improve the means of lighting available to mankind, and our knowledge of the way in which those means may be best employed in the service of our day and generation.

Modern Domestic Lighting

THE eagerly awaited paper by Mr. H. T. Young on the above subject was presented at a meeting of the Illuminating Engineering Society held in the lecture theatre of the Institution of Electrical Engineers, on Thursday, March 19th. There was an excellent audience, the numerous members present being swelled by visitors from the Institution, and from other bodies interested in architecture and in fittings design who had been notified of the meeting. Another pleasant feature was the presence of a number of experts associated with electric lighting organizations abroad, who were in London at the time and who attended *en bloc*.

The chair was taken by the PRESIDENT (Lieut.-Col. Kenelm J. Edgcumbe) at 7 p.m., and, after the minutes of the last meeting had been taken as read, the names of the following applicants for membership were announced:—

Ordinary Members:—

Irwin, Miss Beatrice...Avenue House, The Green, Richmond
Smith, E. R. T.....Secretary of the South African Lamp Association, P.O. Box 4979, Johannesburg.

Country Members:—

French, L.....Electrical Department, Turner, Hoare & Co., Ltd., Apollo Bunder, Bombay, India.
Robinson, H. T. .....Metropolitan Vickers Electrical Co. Ltd., 5, Leasomeside, Leasome Road, Wallasey.

The names presented at the last meeting were read again, and these gentlemen were formally declared members of the Society.*

The PRESIDENT then called upon Mr. H. T. YOUNG to read his paper on "Modern Domestic Lighting." The paper contained a brief survey of recent progress in electric lighting, which has rendered possible greater attention to the artistic aspects of illumination. Many novel and arresting types of lighting fittings were shown in operation, and Mr. Young also illustrated such special decorative uses of light as the lighting up of velvet curtains. Practical hints on the lighting of drawing and dining rooms, bedrooms and kitchens, staircases, etc., followed. In conclusion, the author showed a great variety of views of typical modern interiors, nearly all characterized by distinctive design in lighting equipment and ingenuity in the application of light. He concluded by showing a slide of an early-Victorian interior, in order to show how far we have travelled!

An interesting discussion ensued, in which the following, amongst others, took part: Dr. J. W. T. WALSH, Mr. T. P. BENNETT, Mr. WALDO MAITLAND, Mr. S. CHERNAYEFF, Mr. C. RAPHAEL, Dr. N. A. HALBERTSMA, Mr. RAYMOND MCGRATH, Monsieur MAISONNEUVE, Mr. C. A. MORTON, Prof. V. O. REES, Mr. L. C. KALFF, and Mr. C. MCLEAY.

Mr. H. T. YOUNG briefly replied to various points raised in the discussion. A cordial vote of thanks for his instructive and entertaining paper was moved to Mr. Young by the President and carried with acclamation.

Members appreciated the opportunity of holding this meeting in the fine lecture theatre of the Institution of Electrical Engineers—the lighting of which served as an admirable example of the modern methods described by Mr. Young.

(Mr. Young's paper, and the ensuing discussion, will be dealt with fully in our next issue.—ED.)

* *The Illuminating Engineer*, March, 1931, p. 62.

National Illumination Committee of Great Britain

Chairman's Report for the year 1930, presented at the Annual Special Meeting on Friday, 23rd January, 1931

THE most noteworthy feature during the past year has been the consistent and steady application of the various sub-committees of the National Committee to the technical work preparatory to the 1931 meeting of the International Commission on Illumination.

The British Committee has now accepted the secretariat responsibility for five very important subjects, viz., Coloured Glass for Signal Purposes, Traffic Control Signs, Daylight Illumination, Colorimetry and Lighting Education. The sub-committees appointed by the National Committee to act on its behalf have made every effort to enlist the active co-operation of foreign national committees, and are now preparing reports on the international aspects of their work in so far as it has proved possible to focus attention on international aspects. Progress reports on developments in Great Britain during the past three years in connection with each of these subjects are also in preparation.

As regards those subjects for which the secretariat responsibility has been allotted to foreign national committees, the British sub-committees appointed to work in co-operation with them have all been active. While the responsibility for initiative in those cases necessarily rests with the foreign secretariat committee, the British sub-committees have not remained idle, and have not hesitated to take the initiative in those cases where British opinion was clear or where it seemed that British information and data could usefully be circulated abroad.

The British Sub-committee on Aviation Lighting has been particularly active. Late in 1929 it was considered desirable to hold a meeting of specialists interested in Aviation Lighting in view of the need for early agreement on certain essential features in what is a new and rapidly developing section of the illumination industry. The meeting which was organized under the auspices of the I.C.I. was held in Berlin in April, 1930, and was attended by about eighty delegates from eleven different countries. It proved a distinct success, and has paved the way for fuller discussion at the 1931 plenary meeting.

As mentioned in last year's annual report, the 1931 plenary meeting of the International Commission on Illumination is being held in Great Britain at the invitation of the British National Committee. The meeting of the Commission is to be associated with an International Illumination Congress, which will visit a number of cities in England and Scotland. Technical sessions will be held at these cities, and visits to neighbouring places of technical, historical, or scenic interests will be arranged. The Congress tour is to start in London on September 1st, and will visit Glasgow, Edinburgh, Sheffield, Birmingham and Cambridge, at which latter place the plenary session of the International Commission on Illumination will be held from September 12th to 19th. Visitors and delegates to the Congress and the session of the Commission will thus have an opportunity of studying the present status of the science and technique of illumination in Great Britain, as well as of meeting British and foreign specialists who are playing an important role in the development of what is still a very new industry. Thus the Congress and Commission meetings will finish just before the three days' Faraday Centenary celebrations, organized by the Institution of Electrical Engineers and the Royal Institution of Great Britain, from September 21st to 23rd, and the centenary meeting of the British Association, which begins on September 23rd.

The arrangements for the Congress are being made by the National Committee, which has enlisted the co-operation of the Illuminating Engineering Society. A strong General Council of the Congress has been formed, consisting of prominent individuals and representatives of various organizations interested in Illumination, together with the members of the National Committee and the members of Council of the Illuminating Engineering Society.

The National Committee again wishes to express its thanks to all those gentlemen who have served as members of its sub-committees and have devoted much time and energy assisting the Committee, and hopes that many of them will find it possible to take part in the Congress and Commission meetings.

During the past year the Committee has lost by resignation the services of Mr. F. C. Gorman, who has represented the Institution of Gas Engineers for several years. Mr. H. Davies has been appointed in his place.

The following short reports of the work of the sub-committees have been received:—

I. Sub-Committees on Subjects for which the Secretariat Responsibility is held by Great Britain.

No. 7. Coloured Glass for Signal Purposes.

During the past year a Committee has been formed by the British Engineering Standards Association for the purpose of preparing a specification for coloured lenses for railway signalling. It is hoped that this specification will be available before the 1931 meeting, when it can be considered internationally. The existence of this committee has for the time being prevented the National Committee's sub-committee from working independently on the subject, though all its members are on the British Engineering Standards Association Committee and the international aspects of the subject are not being lost sight of. Progress reports on the subject have been received from co-operating experts in Germany and the United States. A report on progress in Great Britain is in preparation.

No. 7a. Traffic Control Signals.

A questionnaire on Traffic Control Signals has been prepared, and replies have been received dealing with practice in Germany, Great Britain and the United States. These replies have been collated and edited to form one report, which will be presented to the 1931 meeting. A report of progress during the past three years in Great Britain has been prepared.

No. 12. Daylight Illumination.

The British secretariat sub-committee has submitted to foreign co-operating experts proposals (1) defining adequate daylight illumination in interiors used for ordinary clerical work, (2) defining a standard of reasonable fenestration, and (3) outlining a method of determining the effects of obstructions. The replies of the foreign experts—where such have been received—have, however, not as yet proved altogether favourable, and it is probable that some time must elapse before the British proposals receive general acceptance. A report of progress in Great Britain has been prepared and will be presented to the Commission.

No. 15. Colorimetry.

Proposals for a standard white light as the illuminant in colorimetry have been made to co-operating experts. While some differences of opinion have been expressed, it is felt that it will probably be possible to arrive at an

international agreement as the result of further discussion. The British Sub-committee is also hoping to present for international agreement new standard data for colorimetry—the so-called mixture curves of the spectrum. The sub-committee has not been able to make much progress as regards nomenclature, and is of opinion that this subject will be best considered when agreement on the outstanding practical problems has been obtained.

No. 18. Lighting Education.

The sub-committee has reviewed the facilities available at technical institutes and colleges for training in the fundamental principles of illumination and in post-graduate work. An outline has been prepared of a course of six lectures, which it is considered should be suitable for inclusion in the course of study of *all* engineering students. The sub-committee is also considering the extent to which instruction in illuminating engineering, particularly from the daylight point of view, should be given to architectural students.

A short questionnaire has been submitted to foreign co-operating experts, and the replies are being edited.

As a result of the interest aroused by the sub-committee, a course of four lectures on Illumination has already been arranged for architectural students at one of the London colleges.

II. Sub-committees on Subjects for which the Secretariat Responsibility is held by other Countries.

No. 1. Definitions and Symbols.

A set of definitions for the terms used in connection with the transmission, reflection and absorption of light in transparent and translucent materials has been prepared, and has been forwarded to the French Committee with a suggestion that they should be adopted internationally.

Attempts are being made to ascertain whether μ or η is the more generally used symbol for refractive index. It is proposed later to send forward for international adoption whichever appears to be the most commonly accepted symbol.

No. 2. Vocabulary.

The sub-committee is proposing to forward to the Swiss Committee a number of terms for inclusion in the International Vocabulary together with their English definitions. The terms which it is proposed to send are nearly all the terms included in Sections 81, 82 and 83 of the British Standard Glossary (with certain amendments to bring these into accordance with the latest developments), and a few other terms which have been incorporated in specifications issued by the Illumination Industry Committee.

No. 3. Motor Car Headlights.

The proposals and papers submitted by the National Committee at Saranac appeared to the sub-committee to complete the requirements of standardization of lamp and reflector. An investigation to ascertain how far the suggested standardization would result in changes in present practice is being carried out. The sub-committee is also preparing answers to a questionnaire submitted by the American Secretariat Committee.

Nos. 4 and 13. Factory and School Lighting and Cinema Lighting.

The sub-committee has collected, with the assistance of two Inspectors of Factories, data relating to current practice in lighting in certain industries. The data show that there is a growing appreciation of the value of good lighting, especially for fine work, in the industries considered.

The sub-committee has also considered carefully the method of assessing glare originally proposed by the American Committee, and has checked its proposals for limiting grades of glare by data obtained by the Factory Department of the Home Office. For practical purposes (factory inspection) the sub-committee considers it is unnecessary to grade each source or installation in a factory, but merely to ascertain whether it is glaring or non-glaring, and suggests the use of a simple graph which will enable this to be done.

Efforts are being made to obtain the information required to enable the sub-committee to answer the questionnaire on Cinema Lighting proposed by the Japanese Committee.

Nos. 5, 9 and 10. Heterochromatic Photometry, Photometric Test Plates and Photometric Precision.

The sub-committee has circulated a report on the reflecting properties of materials suitable for use as photometric test plates, and has organized tests to determine the accuracy obtained by individuals and institutions using portable photometers in the measurement of illumination. The sub-committee has had the assistance of the Department of Scientific and Industrial Research and the co-operation of about seventeen institutions in carrying out these tests. A report on the subject is in preparation. A report on the precision attained in commercial lamp photometry, in which very wide differences in colour are involved, is also in preparation, and it is hoped that it will be available early in 1931.

No. 6. Street Lighting.

The sub-committee has revised the British Street-lighting Specification No. 307, 1927, during the past year. The revised draft is now ready for circulation to the interested organizations for comment, before it is finally approved for circulation.

The basis of the Specification has not been altered, but certain modifications, which are distinctly in the nature of improvement, have been included. It is hoped that the Specification will be published in time for the meeting of the International Commission on Illumination in September next.

No. 8. Diffusing Materials.

The sub-committee has prepared answers to a questionnaire on the subject proposed by the German Secretariat Committee. Work on the programme of investigations into the properties of diffusing glass is now well advanced, and a report of progress has been prepared for submission to the German Committee. It is hoped that the report of progress will be published as a separate paper by the Commission.

No. 11. Classification of Light Distributions.

The sub-committee's proposals for the classification of light distributions have been submitted to the Belgian Secretariat Committee, and have since formed the basis of British Standard Specification No. 398, 1930.

The sub-committee has also studied the methods of presentation of data on asymmetrical light distributions, and proposals have been submitted to the Secretariat Committee.

No. 16. Applied Lighting Practice.

Questionnaires have been received from the Secretariat Committee in connection with the Store Lighting, Office Lighting, Advertisement Lighting and Floodlighting and are now under consideration. The British sub-committee is also preparing a brief report on developments in Railway Lighting, and is considering the preparation of a statement based on recent surveys of Hotel Lighting and Shop-window Lighting.

No. 17. Aviation Lighting.

The recognition of the importance of some immediate international standardization with regard to aviation lighting led to the organization of a meeting on this subject in Berlin in April. About eighty delegates attended from eleven countries, and a number of important decisions were made. The British sub-committee prepared proposals for discussion, and has subsequently been engaged in formulating the essential requirements of a number of types of lighting equipment used in connection with aviation. A programme of research work into problems of visibility of light signals in clear and foggy weather, as affected by glare and other conditions, has been drawn up, and arrangements are being considered for the prosecution of the work.

K. EDGCUMBE,

23rd January, 1931. CHAIRMAN.

Literature on Lighting

(Abstracts of recent articles on Illumination and Photometry in the Technical Press)

(*Continued from page* 64, *March*, 1931)

In this number we continue the publication of abstracts of articles of interest. Abstracts are classified under the following headings: I, Radiation and General Physics; II, Photometry; III, Sources of Light; IV, Lighting Equipment; V, Applications of Light; VI, Miscellaneous. A panel of abstractors has been formed, and the following, whose initials appear under the items for which they were responsible, have already assisted in the compilation of abstracts: Mr. S. S. Beggs, Mr. F. J. C. Brooks, Mr. H. Buckley, Mr. H. M. Cotteril, Mr. J. S. Dow, Dr. S. English, Dr. T. H. Harrison, Mr. C. A. Morton, Mr. G. S. Robinson and Mr. G. H. Wilson. This new departure seems to have already proved helpful to readers and to members of the Society. Abstracts cover the month preceding the date of publication. When desired by readers we will gladly endeavour to obtain copies of journals containing any articles abstracted and will supply them at cost.—ED.

I.—RADIATION AND GENERAL PHYSICS.

19. The Optics of X-rays. A. H. Compton.

J. Opt. Soc. Am., 21, *pp.* 75-89, 1931.

Reviews evidence of X-rays being a form of light and presents a chart of the complete spectrum of electro-magnetic radiation ranging from radio-waves to cosmic rays. It is shown how X-rays have served to supplement the volume of information regarding the world around us obtainable through the single octave of electro-magnetic waves which gives the sensation of visible light, and details are given of the finer and more detailed knowledge which X-rays, with their shorter wave-length, have enabled us to obtain. The view is emphasized that all X-ray problems are essentially problems of optics.

T. H. H.

20. The Illumination Produced by Plane Diffusing Surfaces. E. Carlevaro.

Elettrotecnica, xviii, *p.* 89, *February 15th*, 1931.

Gives a general method of calculating the illumination produced by diffusing surfaces of non-uniform brightness, oriented at various angles to the illuminated surface.

H. B.

21. On the Amplification of Photo-Electric Currents. H. Simon.

Elect. Zeit., 52, *p.* 264, *February 26th*, 1931.

Different methods of amplification of photo-electric currents are discussed and examples of their application are given.

H. B.

II.—PHOTOMETRY.

22. Photometric Sensibility. E. M. Lowry.

J. Opt. Soc. Am., 21, *pp.* 132-136, 1931.

Data are presented to show that the brightness for maximum photometric sensibility lies between 20 and 30 milli-lamberts*. At such a brightness B, ΔB the least difference of brightness perceptible is given by $\frac{\Delta B}{B} = 1.37$ per cent. The precision of photometric measurements made at such a brightness of the field is such that the average percentage difference of a single observation from the mean is 0.19 per cent.

T. H. H.

23. An Optical Wedge Flashometer. N. H. Brachman and C. W. Kendall.

Rev. Sc. Insts., 2, *pp.* 111-117, *February*, 1931.

Describes an instrument for the study of light flashes of short duration and high intensity. A record of the intensity-time characteristics of the flash is obtained on a photographic film or paper.

F. J. C. B.

24. A Sensitive Light-Counter. B. Rajewsky.

Phys. Zeits., 32, *pp.* 121-124, 1931.

A gas-filled photo-electric cell in series with a high resistance and an electric battery of sufficient voltage to produce intermittent discharges through the photo-electric cell is connected to a 4-valve thermionic amplifier. By counting the number of amplified electric pulses per minute with a "telephone speech counter" a measure of the illumination falling on the photo-electric cell is obtained. It is claimed that this arrangement will detect an irradiation of 9×10^{-11} ergs per sq. cm. per second.

T. H. H.

25. Discharge Lamps in Photometry. v. Göler and M. Pirani.

Licht u. Lampe, *pp.* 67-70, *February*, 1931.

A comparison is first made between the continuous spectrum of the incandescent filament lamp with the line spectrum of the gas-discharge lamp. The characteristic colours of the latter types, which are given on a colour triangle, are stated to introduce considerable difficulties and errors in photometry. For red (neon) and yellow (sodium) tubes filters may safely be employed for the measurements, but with the blue (mercury) tube errors are introduced. The polar curve of a sodium tube is shown to be closely a circle owing to the discharge being opaque, whilst the curve for the neon tube indicates that the intensity falls off much less rapidly as the axis of the tube is approached. Measurements with an anomaloscope show that different observers do not agree as to the colour of the tubes owing to variations in eye sensitivity. When measurements are made in an integrating photometer the selective reflection from the paint may cause errors of 20 per cent. The paper concludes with some illustrations of lighting fittings composed of both filament and mercury-vapour lamps.

G. H. W.

26. The Present Position of Investigations into the Technical Applications of Photo-Electric Cells. F. Schröter.

Licht u. Lampe, *pp.* 63-67 *and* 79-82, *February 20th*, 1931.

The fundamental characteristics of various light-sensitive cells are first considered. Spectral sensitivity and various emission curves for cells having different cathode materials are then given. In the second section the inertia effects in gas-filled cells are first described, and then the effects of spectral shift and sensitivity increase. Finally reference is made to various practical types of cell.

G. H. W.

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* The milli-lambert is the brightness of a perfectly diffusing surface of reflection factor unity when exposed to an illumination of 10 metre-candles.

27. Photo-Electric Cells and their Applications. H. Simon and W. Kluge.

A. E. G. Mitt., pp. 190-195, *March*, 1931.

The underlying principles and laws of cells are described. The particular cells made by the A.E.G. are illustrated and some of their characteristics are reproduced. A record of daylight illumination variations is given, together with a description of the recorder. G. H. W.

III.—SOURCES OF LIGHT.

28. Neon Tube Light and Factors Governing its Life. H. R. Machell.

Frank. Inst., J. 211, *p.* 319, *March*, 1931.

The author describes briefly the action within a gas discharge and its electrical characteristics. The effect of pressure in the cathode fall of potential and the cathode current density are given, and the factors governing sputtering. The conditions for maximum efficiency and for minimum sputtering are stated, together with a description of the effects of electrode material and gas pressure on the life of the tube. S. S. B.

29. Low-Voltage Gas Tubes for Interior Lighting. Anon.

Electronics, p. 493, *February* 2, 1931.

Gives a brief description of discharge tubes for working of 110-220 V. The tubes described are available for industrial and special residential lighting in white, daylight, and all colours. They give an even light distribution without glare. White light is produced about twice as efficiently as from a filament lamp, and in the case of colours the ratio is higher. G. S. R.

30. The Mass Production of Incandescent Electric Lamps. G. Chelioti.

G. E. C. Jour., 1, *p.* 175, *February*, 1931.

A first instalment of an account of the manufacture on mass-production scale of present-day electric lamps. C. A. M.

31. Sources of Illumination for Ultra-Violet Microscopy. B. K. Johnson.

Proc. Phys. Soc., Lond., 43, *pp.* 127-137, 1931.

It is found that a spark between cadmium terminals used with a monochromator, and with a quartz monochromat microscope objective set for a wavelength of 275 Mμ, is the most suitable source of radiation for ultrà-violet microscopy. A description and photograph of a compact and inexpensive unit of this type is given. T. H. H.

IV.—LIGHTING EQUIPMENT.

32. Visible House Numerals. G. F. Prideaux.

Light, p. 30, *February*, 1931.

Gives some details and a photograph of an illuminated house number in which two small lamps are connected across the front door bell-push when the bell circuit is run off a bell transformer. C. A. M.

33. An Office Filled with Sunshine. Anon.

Light, p. 17, *February*, 1931.

Describes a ceiling unit employing one S.1 lamp and eight 100-watt lamps. The transformer for the S.1 lamp may be located directly above the fitting. A table of wire sizes and limiting distances between lamp and transformer is given for use when this location is not possible. C. A. M.

34. New Units for Illumination Purposes. Anon.

A. E. G. Mitt., pp. 197-198, *March*, 1931.

Five new lighting units are illustrated. One is for interior lighting, two are for street lighting, and two are porcelain units for use in damp situations. G. H. W.

35. Standard and Proposed Cut-out Designs for Series Street-Lighting Circuits. H. E. Butler.

Gen. Elec. Rev., 34, *pp.* 112-114, *February*, 1931.

Standard types of film cut-outs are described, together with some new developments. The oxide-coated disc type is already commercially standardized. A mechanical device has been constructed for operating at low voltages—e.g., 75 V. average. Various arrangements of cut-out within the bulb of a series lamp are illustrated. G. H. W.

36. Classification of Lighting Fittings. Z. Yamauti and K. Hisano.

Jour. Illum. Eng. Soc. (Japan), pp. 31-36, *February 20th*, 1931.

This system of classification is based on flux-distribution, class-numbers being assigned to each unit. Direct, indirect, and semi-indirect units may thus be classified, and minor divisions according to the nature of the polar curve are proposed. The method may be applied to assymetric units. J. S. D.

37. The Illuminated Fascia Sign. H. Lingard.

Signs, p. 276, *March*, 1931.

The writer emphasizes the value to merchants of the illuminated fascia sign. Typical methods are illustrated and hints on installation are given. With electricity costing 4d. a unit, the running cost, for a 15 ft. frontage, should not exceed 2d. to 4d. per hour. J. S. D.

V.—APPLICATIONS OF LIGHT.

38. Interim Report, Committee on Light in Architecture and Decoration. Anon.

Am. Illum. Eng. Soc., Trans., 26, *pp.* 102-106, *February*, 1931.

Abstract of a talk by F. W. Gerber, giving an architect's comments on lighting. Illustrated descriptions are also given of seven lighting installations. G. H. W.

39. Architecture and Lighting. K. Sato.

Jour. Illum. Eng. Soc. (Japan), pp. 1-6, *February 20th*, 1931.

A popular lecture showing how developments in the art of lighting were interwoven with progress in house construction, and how later decorative aspects of lighting came to receive consideration. J. S. D.

40. An Analysis of the Literature concerning the Dependency of Visual Functions upon Illumination Intensity. L. T. Troland.

Am. Illum. Eng. Soc., Trans., 26, *pp.* 107-196, *February*, 1931.

A complete review of the literature on the subject, together with exhaustive references up to and including the year 1925. The analysis is sectionalized as follows: 1. General survey of the problem. 2. Absolute sensitivity to light. 3. Fechner's law; discrimination of reflection co-efficients of large areas. 4. Dependency of visual acuity on illumination intensity. 5. Speed of vision as determined by Intensity. 6. The dependency of colour vision upon Intensity. 7. Oculomotor functions, eye-strain, fatigue and injury. 8. The influence of illumination intensity upon practical operations. 9. Summary and conclusions. G. H. W.

41. Fundamentals of Lighting for Landing Grounds. H. Walter.

Licht u. Lampe, 20, *pp.* 43-46, *February 5th*, 1931.

Four units for use as landing lights are considered. One is a portable unit for use on the aeroplane itself, two are high-wattage units for use on the ground, one using a parabolic and the other a trough reflector, and the fourth is a 2-kw. projector, which is normally used with two or three others forming a battery. Diagrams illustrating the positions of lights are given, and two iso-lux curves for 20-kw. and 24-kw. projectors are reproduced.

G. H. W.

42. Experiments on the Artificial Lighting of the Ermitage Art Museum in Leningrad. S. Maisel and E. Jakoview.

Licht u. Lampe, *pp.* 23-24 *and* 46-48, *January and February*, 1931.

Examples are given of solutions of the problems of lighting pictures so as to avoid reflections and lighting statuary so as to obtain the best relief. Various fittings are described and illustrated.

G. H. W.

43. Practical considerations in connection with Good Street Lighting in Country Towns. G. Paris.

Elettrotecnica, XVIII., *p.* 131, *February 25th*, 1931.

Gives examples of calculations of electrical power and lumens required for street lighting with relatively low candle-power lamps in country towns. The calculations are based on tabular values of the lumens required per metre of street to give an average illumination of 1 lux for different mounting heights and street widths.

H. B.

44. Illumination of Highways. C. C. Paterson.

Electrician, 106, *p.* 280, *February*, 1931; *El Rev.*, 108, *p.* 326, *February*, 1931.

Stresses the claims of visibility in commenting upon certain types of street-lighting installations where glare has not been given much consideration or where the British Standard Specification classes have been regarded as an order of merit. Working for a high class with undue economy tends to produce glare.

G. S. R.

45. Show-Window Advertisement "Ipsilux." Anon.

A. E. G. Mitt., *pp.* 105-107, *March*, 1931.

Describes an application of the photo-cell whereby some advertising device in a show window is operated by the presence of onlookers. A beam of light is projected on to a mirror on a post in the street, and is reflected back on to a photo-cell.

G. H. W.

46. Economic Aspects of Factory Lighting. Editorial.

World Power, *p.* 184, *March*, 1931.

Gives a short summary, together with tables of results obtained, of the increases in production in a number of engineering workshops following the introduction of higher levels of illumination. The cost of the installation is given as a percentage of the pay-roll, and is found to be considerably less than the increase in production obtained.

C. A. M.

47. Electric Illumination. Anon.

Electrician, 106, *p.* 275, *February*, 1931.

Gives a short review of recent progress in electric illumination in a number of London business premises. A photograph and some details are given of an original lighting installation of a barber's shop.

C. A. M.

48. Modern Hall Lighting. Anon.

El. Rev., 108, *pp.* 464-465, *March*, 1931.

Gives photographs showing modern tendencies in lighting town halls, ballrooms, etc.

G. S. R.

49. The Lighting of Cinemas. J. Delaporte.

Lux, *pp.* 23-24, *February*, 1931.

General considerations affecting the lighting of cinematograph theatres are briefly outlined; a novel method of lighting installed in the Cinema Victor Hugo is illustrated.

J. S. D.

50. "You may not look out of a window, but you appreciate the view." J. L. Tugman.

Light, *p.* 20, *February*, 1931.

Some particulars are given of a large store in Washington, built without windows. A photograph shows interior lighting produced by continuous troughs suspended from the ceiling. Economic advantages of the scheme are mentioned. An exterior photograph shows that, to all appearances, the store conforms to the conventional lines of construction.

C. A. M.

51. Outdoor Sub-Station Lighting. H. E. Hutter.

El. Rev., 108, *pp.* 460-461, *March*, 1931.

The object of night illumination of sub-stations is to enable attendants to work with safety and to execute urgent repairs and maintenance. For this purpose the principal characteristics of an installation should be a high vertical light component and absence of glare. For this work the author gives a figure of 4 to 6 foot-candles for average illumination. The cheapest method is to use enamelled reflectors mounted overhead. These are liable to cast dark shadows besides being rather inaccessible. The method recommended is wide-angle floodlights mounted on poles with suitable lowering gear alongside the sub-station.

G. S. R.

VI.—MISCELLANEOUS.

52. The Definition of Saturation of a Colour according to Helmholtz. W. Seitz.

Phys. Zeits., 32, *pp.* 112-114, 1931.

A somewhat controversial article upon the significance of various factors concerned in colorimetry.

T. H. H.

Sheffield Illumination Society

A party of members of the Sheffield Illumination Society and friends was conducted over the Sheffield Corporation Tramways Depot at Tenter Street, on March 2nd.

On the ground floor there is accommodation for 90 tramcars. The first floor has sufficient parking space for about 160 motor buses. As the depot is open day and night, an efficient lighting installation is essential.

Industrial-type reflectors housing 300-watt lamps have been installed in rows, the spacing being closer where the tramcars are housed than in the garage. The lighting conditions are considered very satisfactory, the whole depot being flooded with an evenly diffused light entirely free from glare.

In the various rooms, such as time office, booking office, mess room, etc., bowl-type fitting is employed housing 100-watt lamps. The numerous points of interest were explained to the party by efficient guides, who spared themselves no trouble in making the visit enjoyable and instructive.

POPULAR & TRADE SECTION

COMPRISING

Installation Topics—Hygiene and Safety—Data for Contractors—Hints to Consumers

(The matter in this section does not form part of the official Transactions of the Illuminating Engineering Society and is based on outside contributions.)

International Illumination Congress (September, 1931)

SPECIAL FLOODLIGHTING ARRANGEMENTS

This important Congress will be attended by delegates from all parts of the world, and there is, therefore, a special opportunity to show our visitors examples of lighting technique as practised in this country. During their stay in London, it is anticipated that the visitors will make a river trip from Westminster to the Tower of London, and a special effort is therefore necessary for making the lighting of the river frontage as spectacular as possible. Arrangements are in hand for floodlighting the public buildings, such as:—

The Big Ben Tower of the Houses of Parliament,

Somerset House,

Buckingham Palace, and

The Lighting of the Embankment by St. Thomas's Hospital.

Consideration is also being given to providing illumination of some of the bridges.

It is therefore hoped that those interested will do all they possibly can to persuade the owners of suitable sites in Central London, and especially the sites on either side of the river, to have effectively illuminated premises, and take steps to make suggestions of floodlighting, signs, and other spectacular lighting to the owners of these sites which will be worthy examples of illumination practice in this country and be of permanent value as features of the buildings themselves.

A communication from the Secretary of the Congress has already been sent to the owners of buildings fronting the river between Westminster and the Tower Bridge, seeking their co-operation in this respect, and it is hoped that this will be followed up as closely as possible by all interested in this class of work.

E.L.M.A. Illumination Design Course May 4th-8th, 1931

We have before us a booklet describing the 23rd Illumination Design Course which will open on May 4th at the Lighting Service Bureau, 15, Savoy Street, London, W.C.2. The course comprises 24 lectures, each given by a specialist, and all dealing with topics of considerable interest. The series of lectures and demonstrations affords an excellent opportunity to all those interested in electric lighting of bringing themselves up to date on this subject. Further particulars may be obtained on application to the Lighting Service Bureau at the above address.

Lighting at the British Industries Fair, Birmingham

We hope in our next issue to present a fuller account by our correspondent of lighting at the British Industries Fair, Birmingham. For the moment we must content ourselves with recording some of its chief features.

Birmingham is naturally an excellent industrial centre for the display of British goods, and its Chamber of Commerce has shown itself particularly active and enterprising in the development of the fair, which has, since 1925, become an accepted international event. Both gas and electric lighting were strongly represented. Amongst the bodies interested in the gas side may be mentioned the Society of British Gas Industries, the National Gas Council, the Institution of Gas Engineers, and the British Commercial Gas Association, whilst on the Advisory Committee of the electrical section such bodies as the Institution of Electrical Engineers, the Electrical Contractors' Association, the British Electrical Development Association, and the Electric Lamp Manufacturers Association of Great Britain Ltd. were represented.

In the exclusively electrical section the number of exhibitors attained 118, a very creditable figure, and the display covered a very wide range—from such relatively small items as switches and lampholders up to a complete sub-station for electrical supply. In the gas section the number of exhibitors, 68, was somewhat less, but the range of this typically British industry was equally impressive. Many of the lighting units shown in both sections were of interest, and the experiments in public lighting proceeding in certain streets of Birmingham furnished yet another spectacle of interest.

A Review of Street Lighting

On the 9th March, at the Corporation Lighting Department, Sheffield, members of the Sheffield Illumination Society listened to an interesting and instructive paper on "A Review of Street Lighting," by Mr. A. L. Williams, a member of the Departmental Staff.

Mr. Williams prefaced his paper with a brief history of street lighting showing a few old type burners and electric lamps, comparing them with the present burners and lamps, and reviewing modern public lighting. Special reference to glare and distribution by means of refractors and reflectors was made. The lecturer also alluded to the maintenance of installations, the solution of problems being illustrated by carefully prepared detailed drawings and practical demonstrations.

Mr. J. Styring, President of the Society, presided.

Some Notes on Lighting Developments in Australia

By E. W. HARMER, A.M.I.E.E., A.M.I.E. (Australia)

RAPID development in all phases of lighting has taken place in Australia of recent years.

The average Englishman visiting Sydney for the first time would most probably be struck by its apparent American atmosphere, and to a certain extent this is reflected in the lighting equipment. The reasons for this are of course not difficult to find. Firstly there is the closer proximity of the States (which ensures more rapid delivery and communication), and secondly the strong American business representation which exerts every endeavour to place its products in Australasia. A further factor assisting American competition is the fact that more of the standard lighting products are suitable for Australian conditions than those of British design.

In street lighting, for example, the totally enclosed unit is considered essential owing to the high maintenance costs of ventilated fittings under Australian conditions. In the city of Sydney, owing to the rather narrow streets, central suspension units with directive refractors and in many cases rippled outer diffusing globes are employed. Melbourne, on the other hand, has large wide streets, and post top diffusing units, similar to the usual American types, are arranged on each side of the street. The efficiency is naturally considerably less than that obtained with a central suspension system, but the simpler maintenance, enhanced daylight apearance and lower glare is considered by the authorities to outweigh the additional cost of current. In the suburbs and country districts light and power for both street lighting and domestic use is supplied by overhead distribution. In a certain number of districts the series system of street lighting is employed.

Shop Windows and Stores Lighting.

The lighting of shop windows has everywhere in Australia been greatly improved during the last decade. The usual system of individual silvered glass, prismatic glass, or metal reflectors is employed. Colour lighting does not appear to be utilized to a very large extent yet, but its value as a sales force will be more appreciated in time. Shop windows are tastefully and artistically dressed, combining the best features of European and American practice. The intensities of illumination would compare in many cases unfavourably with those found in London, with certain notable exceptions. As far as the author can judge, more use appears to be made of the 200-watt unit for this phase of lighting than in England. The larger 300 and 500 watt reflectors are also more frequently installed.

Interior Commercial and Stores Lighting.

Interior lighting of stores and commercial buildings follows the general lighting system with *totally enclosed* fittings up to 500 watts. Certain units, in which a lamp replacement can be made without unscrewing or touching any metal work and which prevent the tiniest insect from finding its way into the interior of the unit, find a ready market. An interesting example of stores lighting, unique probably in its spacing of units, is that of Messrs. Farmers, the well-known Sydney stores. Artificial daylight units each equipped with a 1,000 or 1,500 watt lamp are arranged with a spacing of 33 feet by 30 feet, perhaps the largest spacing in the world for satisfactory stores lighting. Such a system could not, of course, be used in many stores, but here, where the goods are widely spread apart, the results are very satisfactory.

Modernistic designs for stores and commercial lighting are now beginning to be adopted, but to a considerably lesser extent than is noticeable in London.

Floodlighting.

Floodlighting of buildings appears to have developed more rapidly in some of the smaller cities than in others of much larger size. Thus one finds that Brisbane has more floodlighting than Sydney. (The somewhat narrow streets in Sydney prejudice the commercial value of this form of publicity.) Colour floodlighting is as yet hardly used, but will undoubtedly come into its own later. The floodlight projector for service in Australia must be of strong type, totally enclosed and capable of standing up to torrential rainfall.

The value of floodlighting for railway yards and tracks is appreciated in Australia to a far greater extent than here, and is almost universally employed. Banks of two or four projectors at least 50 feet high, having a narrow beam of about 12 degrees and for use with 1,500-watt lamps, is the system used. In running cost and maintenance this system has enormous advantages over the older systems.

Railway Lighting.

In addition to the efficient and economical lighting of railway yards the various Government railway engineers seem to have studied the question of efficiency before that of initial cost. One finds, for example, that the lighting of a platform and station is often carried out by metal-protected glass reflectors, silver mirrored or prismatic, instead of the more simple but less efficient vitreous enamel reflector of suitable design.

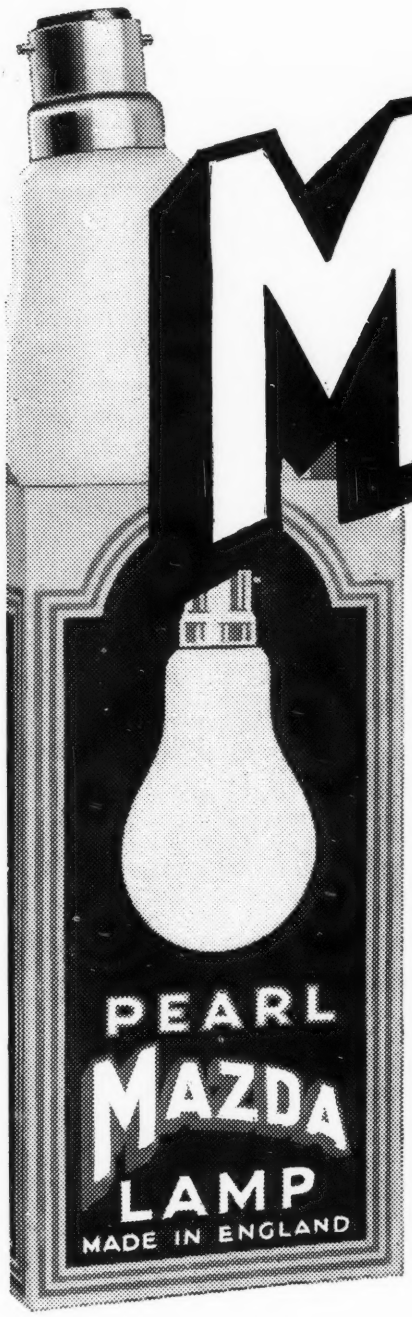
Cinema Lighting.

Great improvements in the design and lighting of cinemas have taken place in Australasia during the past few years. A number of Spanish design and equipped with "atmospheric" colour lighting have been erected in the principal cities with luxury equipment. (It may interest readers to know that smoking is prohibited in almost every cinema and theatre in Australia.) The recently erected State Theatre is a particularly fine example of architectural beauty and lighting effects. Its design is based on the famous Roscy Theatre, but it incorporates ideas picked up by the architect in his tour of the cinemas and theatres of America and Europe.

Domestic Lighting.

Many houses and bungalows built during the past five years also reflect the Spanish design, and consequently, the demand for lighting fixtures of this type has been marked. American three and five light fixtures of somewhat ornamental appearance are extensively used, in many cases because of their comparative cheapness.

There is a tendency also to use more decorative totally enclosed fittings in the place of the usual bowl fittings (which naturally form a trap for flies and insects, etc.). There is a small demand for Period fixtures and an increasing demand for Modernistic designs.



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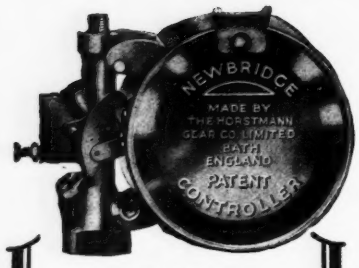

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Lighting of Sports and Playing Areas.

As in most other countries, dirt tracks, greyhound racing tracks, and many sports areas are now illuminated by night. Particularly noticeable is the fact that a very large number of tennis courts are lighted for night play. Both the overhead and the side lighting systems are employed, the latter predominating. With this system six angle reflectors per side are used with a total consumption of 12 kw. for one court.

The floodlighting of surfing beaches (the projectors being arranged in groups on towers) is now being extensively employed. Floodlights with copper housings are essential to combat the effect of the salt sea atmosphere. The lighting of air ports is only in its infancy at present in this vast continent.

Australia, with its cities separated by such great distances, is considered by many to be the finest flying country in the world. It is obvious that a great field exists in the lighting of air routes and air ports for night flying.

Hoarding Lighting and Illuminated Signs.

Almost all hoardings are electrically illuminated, but the number of illuminated signs and the general effects and designs are disappointing. The use of the neon sign is coming more and more into favour. Progress in this field has been slow, partly owing to the somewhat drastic municipal restrictions which govern the erection of signs in the chief cities.

Industrial lighting hardly needs comment as it follows the systems universally in vogue. There are, of course, as in every country, a large number of factories still indifferently lighted, and intensive propaganda in this field is still needed.

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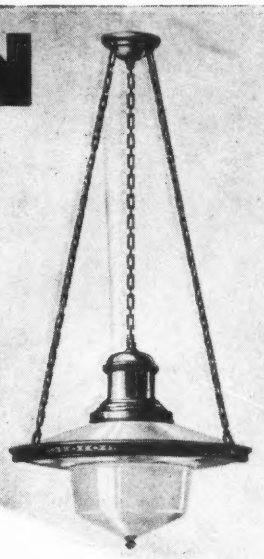

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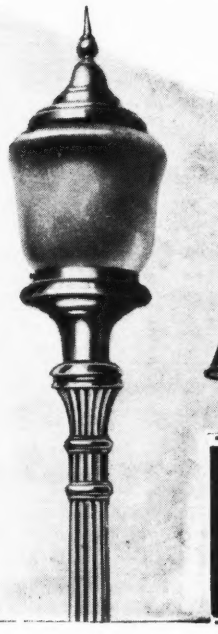

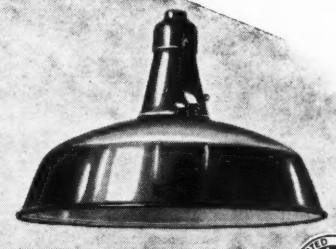

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TRADE NOTES & ANNOUNCEMENTS

Some Recent Lighting Installations

A number of novel and interesting installations designed by the Benjamin Lighting Engineering Service have been carried out recently, and particulars of one connected with furniture spraying were given by Mr. Howard Long, A.M.I.E.E., at the recent Problems Meeting held by the Illuminating Engineering Society, which is reported in this issue.

Amongst other notable installations described at the same meeting may be mentioned the Kingsway Subway Tunnel (described by Mr. J. H. Parker) and the floodlighting of the Singer Sewing Machine Co.'s Building, which was handled by Mr. R. A. Ives (Edison Swan Electric Co. Ltd.). The latter was a problem demanding considerable ingenuity, whilst in the Kingsway Subway the floodlighting of the stations by means of Holophane reflectors and the illumination of the tunnels by mirror-reflectors of the Bi-Multi type appear to have been very successful.

The "Wigan Review"

The March number of the *Wigan Review*, issued by Messrs. Heyes & Co., refers to the Wigan mining-type fitting as "something old" and familiar, and to the angle-type explosion-proof fitting as "something new." Amongst recent installations in which "Wigan" prismatic bulkhead fittings are installed, the new North of Ireland Parliament Buildings, Belfast, are illustrated. A pleasing river picture and a brief reference to the Wigan Rowing Club complete this issue.

New Hailware Fittings

From Messrs. Hailwood & Ackroyd Ltd. we receive pleasing views of "Hailware" decorated shades, illustrated in colour. Other novelties are the Hailware balloon fittings, clusters of spheres executed in various colours, and the "cubalite" ceiling fittings, utilizing the cubes in diffusing glass which are now becoming so popular. The same idea has, however, been extended to include cylindrical, triangular and other shapes, all executed in three-ply opal glass.

We learn incidentally that one of the firm's sample cars was recently stolen in London; the car was recovered, but its contents of Hailware decorated shades and globes had vanished—a flattering but inconvenient proof of their attractiveness!

The "Credalux" spotlight, a novelty shown by Credenda Conduits Ltd. at the British Industries Fair, Birmingham. The reflector is made of untarnishable chromium-plated finish metal. It is claimed to be practically indestructible, and the direction and angle of beam can be readily adjusted within wide limits.

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